PB-229 291

REPORT OF WATER POLLUTION STUDY OF MAUMEE RIVER BASIN, 1950-1951

Ohio Department of Health
Columbus, Ohio

April 1973

DISTRIBUTED BY:

NTIS

National Technical Information Service
U. S. DEPARTMENT OF COMMERCE
5285 Port Royal Road, Springfield Va. 22151

PB 229 291

REPORT OF

WATER POLLUTION STUDY

OF

MAUMEE RIVER BASIN

1950 - 1951

Prepared by

WATER POLLUTION CONTROL UNIT

SANITARY ENGINEERING DIVISION

OHIO DEPARTMENT OF HEALTH

In Cooperation With

INDIANA STREAM POLLUTION CONTROL BOARD

and

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

OHIO - TENNESSEE DRAINAGE BASINS OFFICE

APRIL, 1953

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U S Department of Commerce
Springfield VA 22151

FOREWORD

This report summarizes a comprehensive water pollution study of the Maumee River Basin. Pollution was evaluated for the entire drainage basin; its effect under known hydrological conditions was observed, and the degrees of pollution reduction necessary to meet stream water quality objectives consistent with water usage were determined. Due allowance was made for the natural purification capacity of the river and its tributaries during periods of critical flows.

Cognizance should be taken that pollution reduction calculations are based on minimum seven-consecutive-day stream flows which, according to probability studies, are expected to be equaled or exceeded in 80 percent of the years. Occasionally, therefore, it is to be expected that, under extreme drought-flow conditions, the pollution reduction requirements will not meet completely the water quality objectives. However, it is considered unreasonable to require corrective measures to meet these extreme conditions.

It is believed that such basic data as contained in this report, adjusted as necessary to take into account municipal and industrial growth, will serve as the best approach to a sound and reasonable water pollution abatement and control program. This program has as its primary objective the restoration and preservation of waterways for uses consistent with the best interests of our States, our people, and our industries.

739

CONTENTS

	Page
FOREWORD	ii
INTRODUCTION	1
ACKNOWLEDGMENT	3
CONCLUSIONS	5
SECTION I - GENERAL	
STATUTORY PROVISIONS IN MATTERS RELATING TO WATER POLLUTION	11
OBJECTIVES	15
ACQUISITION AND PRESENTATION OF SURVEY DATA	23
METHODS USED FOR ANALYSIS OF STREAM CONDITIONS AND NECESSARY REDUCTION OF ORGANIC POLLUTION LOAD	27
SECTION II - DETAILS	
DESCRIPTION OF MAUMEE RIVER BASIN	31
Geography	
Physiography	
Geology	
Ground Water Storage in Relation to Stream Flows	
Water Development	
Population	
Industry	

	Page
HYDROLOGICAL DATA	37
WATER USES	39
SOURCES AND EXTENT OF POLLUTION	43
Wastes Having Significant Biochemical Oxygen Demand	
Wastes Causing Bacterial Pollution	
Wastes Having Other Effects	
POLLUTION ABATEMENT REQUIREMENTS	53
APPENDIX	
Figure 1. - General Reference Map	61
Figure 2. - Stream Mileage Chart	62
Figure 3. - Location of Sampling Stations	63
Table 1. - Population Trends, 1900 - 1950	64
Figure 4. - Population Trend	65
Table 2. - Distribution by Subwatershed Areas of Population in Community Pollution Sources	66
Figures 5A - 5H. - Low Flow Frequency Curves	67
Table 3. - Critical Flows At Gaging Points on Maumee River and Tributaries	75
Table 4. - Summary of Public Water Supply Information	76
Table 5. - Data on Sources of Pollution - Municipalities with Population Over 5,000	79
Table 6. - Data on Sources of Pollution - Municipalities with Population Under 5,000	80
Table 7. - Data on Sources of Pollution - Industries	82

	Page
Table 8. - Summary of Bacteriological Results	86
Table 9. - Summary of Industries Having Deoxygenating Wastes	87
Table 10. - Summary of Industries Having Significant Wastes Other Than Deoxygenating Materials	88
Figure 6. - Sources of Significant Pollution	90

INTRODUCTION

Water is our most important natural resource, from either a domestic or an industrial viewpoint. Despite otherwise favorable conditions for expanded economic development in the Maumee River Basin, it is now realized that such development is dependent upon the success of water conservation measures. The fact that the demand in several sections of our States has approached and, probably in some instances, gone beyond the available supply has been a potent factor in the instigation of water conservation measures.

The importance of maintaining the streams in conditions commensurate with their potential uses has, in the past, been given little attention by the general public. Local, State, and federal public health agencies, as well as conservation and recreational groups, have recognized the significance of the problem and have endeavored within the authority provided to promote better stream conditions. Within the past few years, however, there has been a more or less general awakening to the seriousness of the problem. As a result, enabling legislation for the control of water pollution has been enacted. Statutory authority of the Ohio Department of Health and of the Indiana Stream Pollution Control Board, respective regulatory agencies in matters relating to water pollution, is summarized elsewhere in this report.

During the summer and fall of 1950 and 1951, representatives of the Ohio Department of Health and of the Indiana Stream Pollution Control Board cooperated in making a detailed pollution survey of that portion of the Maumee River Drainage Basin which lies within the two bordering States. The portion of the basin which lies within the State of Michigan is so small in area, and sources within that area contribute such an insignificant amount of pollution, it was not felt necessary to include it in the survey. This report summarizes the information obtained during the survey and the conclusions reached after analyzing the information.

In addition to the pollution survey data collected in 1950 and 1951, other data and information have been obtained or assembled from other sources for the purposes of the study and report. Generally, information on existing treatment, required treatment, and similar matters reflect the situation as of March 1953. Population studies are based on Bureau of the Census reports through 1950. Data on bacterial concentrations at public water supply intakes obtained since the survey have been used to supplement the survey data in making the analyses of pollution abatement needs.

The Ohio and Tennessee Drainage Basins Office, Division of Water Pollution Control, Public Health Service, Department of Health, Education, and Welfare, has assisted the States involved in the correlation of data and in the preparation of this report. This is in keeping with the intent of the Federal Water Pollution Control Act to recognize, preserve, and protect the primary responsibilities and rights of States in controlling water pollution and to prepare or adopt comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof in cooperation with State water pollution control agencies. As provided by Public Law 845, the Surgeon General, Public Health Service, has reviewed this report and has determined that it meets his requirements for a comprehensive program.

The survey data and this report generally cover the entire drainage area lying within Ohio and Indiana, although there may be isolated instances where some further investigation will be necessary. It will be found that many of the smaller municipalities and industries on the tributaries are not mentioned. This, for the most part, is an indication that analytical results did not indicate pollution of material significance of the streams on which they are located. It is not an indication, however, that such municipalities or industries will need no sewage or industrial waste treatment. As signatory States to the Ohio River Valley Water Sanitation Compact, both Ohio and Indiana are guided by the interstate policy of minimum treatment for all sewage and industrial wastes. Legislation adopted in the respective States supports this policy. However, in the approach to the over-all pollution abatement program, greatest emphasis must be given to the correction of the most serious problems first.

ACKNOWLEDGMENT

The invaluable cooperation and assistance furnished by both governmental and private agencies during the course of this pollution abatement study is gratefully acknowledged. Only through the splendid aid given by these organizations and their personnel was it possible to obtain the necessary information for proper evaluation of the pollution problem.

Municipal officials and water and sewage treatment plant personnel gave the survey agencies excellent cooperation, not only by supplying information relative to plant operation but also essential data on possible sources of pollution and on the character and quantity of wastes. Cities where the mobile laboratory was stationed provided water, electric power and numerous other items.

Industrial management and personnel likewise extended full cooperation. The general interest that was shown towards the efforts of water pollution control was most gratifying. In many instances both personnel and facilities were made available to assist in obtaining the necessary survey data.

The U. S. Geological Survey (Ohio and Indiana Districts), the Division of Water Resources of the Indiana Department of Conservation, the Ohio Department of Public Works, and the Division of Water of the Ohio Department of Natural Resources all cooperated by supplying stream flow data and drainage basin information.

CONCLUSIONS

1. The Ohio Department of Health and the Indiana Stream Pollution Control Board conducted a comprehensive field survey of water pollution in the Maumee River Basin in 1950 and 1951. The survey has identified the significant sources of pollution throughout the Basin and has provided data on the types and magnitude of pollution being discharged to surface waters.

2. The survey data and analyses of their significance provides evidence that damaging effects on water quality existed at the time of the survey, which impaired reasonable and necessary water uses and endangered public health. Flows in the streams at the time of the survey were higher than those which can be expected during drought flow periods. Damages from pollution will be more serious during such periods than were witnessed at the time of the survey.

3. Water quality objectives are directed toward securing and maintaining water of suitable quality for those uses which, in the public interest, are reasonable and necessary.

4. In determining minimum pollution abatement requirements, due allowance has been made for the natural waste assimilating capacity of the receiving streams, determined under conditions of "critical" low flow. Critical low flow is defined as the minimum seven-consecutive-day average flow which can be expected to be equaled or exceeded in 80 percent of the years.

5. Pollution abatement requirements indicated herein are based on existing pollution loads. Additional requirements will be necessary should increased pollution loads endanger those water uses which are reasonable and necessary in the public interest.

6. Detailed mathematical analyses of requirements, using field data and theoretical formulas, were practical only for the main stem of the Maumee River since, at all focal points of pollution on the tributaries, except for a few comparatively small sources of pollution, the pollution load was so great in relation to critical stream flow that the need for a high degree of treatment is apparent without detailed mathematical analyses.

7. Summary of municipal requirements for pollution abatement at sewered communities:

Requirements	Number of Municipalities	1950 Population	Population Equivalent Before Treatment	Population Equivalent Discharged To Stream
Ohio				
New Plant	35	70,184	84,060	84,060
Enlargement, Addition, or Replacement	8 (1)	400,883 (1)	627,790 (1)	359,650 (1)
None	6	22,762	32,120	1,960
Indiana				
New Plant	5	15,658	20,850	20,850
Enlargement, Addition, or Replacement	2	3,328	2,580 (2)	2,580 (2)
None	4 (3)	142,122 (3)	135,090 (3)	20,240 (3)

(1) Includes Toledo, Ohio, with a 1950 population of 303,616.
(2) Ineffective treatment in septic tanks.
(3) Includes Fort Wayne, Indiana, with a 1950 population of 133,607.

8. There are six communities in Ohio, with a total population of 3,990, which have public water supply systems but do not have comprehensive public sewer systems. There are three such communities in Indiana, with a total population of 3,349. These communities contribute only a small pollution load to the streams at this time.

9. Summary of industrial requirements:

Requirements	Total Number of Industries	Industries with Wastes Having B. O. D. (1)			Industries With Wastes Having Other Effects
			Pop. Equivalent		
		Number (3)	Before Treat.	As Discharged (2)	Number (3)
Ohio					
New treatment facilities or other method of controlling wastes.	26	24	181,950	181,950	8
Replacement, Enlargement, or Addition of other methods of control	23	23	313,870	279,780	6
None	5	4	16,390	60	2
Indiana					
New treatment facilities or other method of controlling wastes.	6	4	21,920	21,920	3
Replacement, Enlargement, or Addition of other methods of control	3	2	4,520	1,000	1
None	4	3	3,390	180	1

(1) Biochemical oxygen demand.
(2) Excludes canneries which have lagoons and controlled discharge on the basis that loads are not released during low flow periods.
(3) Industries are included in both of these columns if they contribute wastes having both B. O. D. and other effects.

10. Degree of municipal and industrial organic pollution reduction required at focal points of pollution (expressed in terms of B.O.D. reduction):

Toledo Area. - Not less than 85 percent.

Fort Wayne Area. - The municipalities of Fort Wayne and New Haven now provide treatment capable of removing 85 percent of the municipal load. Comparable treatment of industrial wastes should be provided.

Maumee River above Toledo in Ohio. - A reduction of 65 percent will provide reasonable protection for water uses.

Tributaries. - With a few exceptions at minor sources of pollution, treatment to remove at least 85 percent of the load is required. At many focal points of pollution, notably in the Lima, Findlay, Ottawa, Van Wert, Archbold, Delphos, and Ohio City areas, the highest degree of treatment practical of attainment is required.

11. Disinfection to protect public water supplies should be provided at Defiance and Napoleon at this time. Other municipalities not now providing disinfection may be required to do so in the future.

12. Treatment or other control is required for oil wastes from oil refineries and other industries in the Toledo, Lima, Findlay, and Fort Wayne areas; for wastes from plating industries at Delphos, Spencerville, Bluffton, Fort Wayne, and St. Marys; for phenolic wastes in the Toledo, Waterville, Auburn, and Lima areas; and for miscellaneous industrial wastes in the Fort Wayne, Defiance, Toledo, St. Marys, and Findlay areas.

SECTION I
GENERAL

Preceding page blank

STATUTORY PROVISIONS IN MATTERS RELATING TO WATER POLLUTION

Ohio

The Ohio General Code provides regulatory statutes pertaining to sewerage and sewage disposal, industrial wastes disposal, and stream pollution.

The first legislation was adopted in 1893 with the enactment of a law to require municipalities to submit plans of proposed sewerage and sewage treatment works (Section 1240 G. C.) to the Ohio Department of Health. In 1925 this law was clarified and amended, resulting in currently effective acts codified as Sections 1240, 1240-1, 1240-2, and 1240-3 of the General Code. These sections are directed specifically toward water pollution control. For example, Section 1240-1 relates exclusively to industrial wastes disposal. It makes mandatory the approval by the Department of Health of plans of proposed industrial wastes treatment and disposal facilities for all new works and all changes of works in which liquid wastes are produced. Section 1240-2 gives the Department general supervision over the operation of sewage treatment works and of industrial wastes treatment and disposal facilities; submission of performance records and pertinent information may be required. Section 1240-3 imposes obligations upon the Department. To study the lakes and streams; to determine uses of the waters and causes contributing to pollution; and to determine the practicability of abating and correcting their pollution so as to prevent damage to public health and welfare. Also the Department is authorized to adopt and enforce regulations relative to water pollution control.

In the interim of development of the legislation as cited above, the so-called Bense Act (Sections 1249 to 1261 G. C.) was adopted. This provided, on proper petition or complaint, for action by the Department comprising investigation, finding, hearing, and order for correction of water pollution resulting in nuisances damaging to public health or comfort or pollution of a public water supply. This act required proof of such insanitary conditions as might be caused by discharge of "sewage and other wastes" into the receiving stream. Findings and orders of the Director of Health were subject to approval by the Public Health Council. Amended and tested during the years, the law remains effective. Important legal features are (1), that an order of the Director of Health is prima facie evidence in a lawsuit on account of water pollution; and

(2), that mandamus proceedings in the Ohio Supreme Court have been successful in enforcing compliance with an order of the Director of Health.

The 98th Ohio General Assembly in 1949 adopted a law, the Raegan Act, codified as Section 1240-4. The intent of this legislation was to make it unlawful to discharge untreated sewage and industrial wastes into waterways of the State. Violation was made a criminal offense but no procedure was prescribed for administering the act and the ability to enforce this law has been questioned. In accordance with the provisions of the law, 30 cities not provided with sewage treatment works were cited by the Director of Health in June, 1951, and the Attorney General was requested to prosecute. This legislation, by court ruling, is superseded by the water pollution control act referred to in the following paragraph. Consequently, procedure under the Raegan Act has been discontinued in favor of the administrative and enforcement provisions of the new law.

The "Water Pollution Control Act of Ohio", section 1261-1a to 1261-1i, G.C., inclusive, commonly referred to as the Deddens Act, was adopted by the 99th General Assembly of Ohio in 1951. This law, effective September 27, 1951, created a Water Pollution Control Board in the Ohio Department of Health with powers, among others: To prevent, control, and abate new or existing pollution of the waters of the State; to issue, modify, or revoke orders for abatement of pollution and for construction of suitable facilities to prevent, control, and abate pollution; to issue, revoke, modify or deny permits for the discharge of sewage and industrial wastes to waterways of the State; and to institute or cause to be instituted in common pleas court having jurisdiction proceedings to compel compliance with the provisions of the act or with orders of the Board. Basically this law represents a real effort to establish a comprehensive State program of pollution control.

Indiana

The first effective law for pollution control in Indiana was enacted in 1935 and administered by the Department of Commerce and Industry. The Department was abolished in 1941, thereby nullifying the legislative act of 1935.

The Indiana Stream Pollution Control Board, consisting of seven members, was created by legislation contained in Chapter 214, Acts of 1943 (amended by Chapter 132, Acts of 1945). The Secretary of the State Board of Health, the Director of the Department of Conservation, and the Lieutenant-Governor serve as ex-officio members. The remaining four members are appointed by the Governor, no more than two of which shall be of the same political party. The appointments are made to afford additional representation of the various interests in water pollution control. The law provides that all engineering assistance be provided by the State

Board of Health with the Chief Sanitary Engineer serving as Technical Secretary of the Board.

The Board is empowered to make determinations, and issue orders and regulations governing stream pollution. The Act provides for (1) prohibiting pollution of any waters of the State, (2) the raising of funds by municipal corporations, and (3) penalties for failure to comply with orders of the Board.

The Administrative Adjudication Act, Chapter 365, Acts of 1947, contains certain procedures to be adhered to by most of the State departments relative to hearings, issuance of orders, etc. This act supersedes certain sections of the Stream Pollution Control Law.

Interstate Legislation

The Ohio River Valley Water Sanitation Compact, formally adopted June 30, 1948, comprises an interstate agreement between eight signatory States having areas in the Ohio River drainage basin. Ohio and Indiana, with the six other States, (New York, Pennsylvania, Illinois, Kentucky, West Virginia, and Virginia), pledged the enactment of such legislation as was necessary to enable the respective States to comply with the terms of the Compact. Significant requirements of the Compact include (1) a minimum degree of treatment for all sewage wastes; (2) a higher degree of treatment for sewage wastes if conditions warrant; and (3) modification or treatment of industrial wastes to protect the public health or to preserve the waters for other legitimate purposes.

Federal Legislation

The Federal Water Pollution Control Act, Public Law 845, passed by the 80th Congress in June of 1948, as amended, is directed at the control of water pollution through the cooperative efforts of Federal, State, and interstate water pollution control agencies and the municipalities and industries involved.

In part, the Act provides that the Surgeon General of the Public Health Service shall: Prepare or adopt comprehensive programs for eliminating or reducing the pollution of interstate waters and tributaries thereof and improving the sanitary condition of surface and underground waters in cooperation with other Federal agencies, State water pollution control agencies, and interstate agencies, and with the municipalities and industries involved; encourage cooperative action and compacts between States and the enactment of uniform State laws for the prevention and abatement of pollution; conduct research and collect and disseminate information relating to water pollution; support and aid technical research to devise and perfect

methods of treatment of industrial wastes which are not susceptible to known effective methods of treatment; and furnish assistance to State agencies as may be authorized by law.

Pollution of interstate waters which endangers the health or welfare of persons in a State other than that in which the pollution originates is declared to be a public nuisance and subject to abatement as provided by the Act.

The law recognizes, preserves, and protects the primary responsibilities and rights of States and makes provision for lending assistance and financial aid to interstate and State agencies in the formulation and execution of water pollution programs.

OBJECTIVES

The basic objective of the proposed program for abatement and prevention of pollution in the Maumee River Basin is to secure and maintain a water quality in the various streams and sections of streams suitable for those uses which, in the public interest, are reasonable and necessary.

Establishment of treatment requirements, or other corrective measures, for wastes discharged to the streams involves the proper correlation of several factors so that the final waste effluents will be consistent with the basic objective. The factors involved include quality and quantity of wastes discharged, dilution and natural purification capacities of the receiving streams, water uses, population and industrial growth trends, economic balances between pollution abatement costs and benefits received, and quality of water required for the various uses.

The water pollution survey by the States and information from other sources provide data on wastes discharged, stream flows, population trends, and water uses which are presented elsewhere in this report. This section is concerned primarily with water quality objectives to be applied in correlation with other factors.

It is recognized that the water uses may vary for different streams and for different sections of a particular stream. Also, the maximum allowable concentrations of polluting substances will vary with the different water uses. Furthermore, the effects of a particular substance may also vary depending on the presence or absence of other substances in the receiving waters.

It is also recognized that consideration must be given to the economic balance between the cost of pollution prevention or abatement and the benefits received. This balance is not necessarily the same for reclamation of polluted waters as for the preservation of relatively unpolluted water; consequently, water quality objectives formulated for the purpose of restoring a polluted stream or section of a stream to a minimum quality consistent with downstream water uses cannot be considered as inviting the lowering of the water quality of cleaner streams throughout the basin.

In the application of water quality objectives, consideration must be given to provision for proper sharing of water resources, provision for

future development, and other special needs in the public interest. For example, minimum correction of an upstream waste discharge to comply with maximum permissible concentration at that point could result in the usurpation of the dilution capacity of the stream for many miles, leaving a disproportionately small capacity for dilution of similar waste from existing or potential sources downstream.

Use of the surface waters of the basin for public water supplies is a high priority need. Water quality objectives, designed to meet the requirements of this use, will be applied to protect existing and future supplies.

For the reasons discussed above, water quality objectives established to maintain the basin's waters in a condition suitable for reasonable and necessary uses must be sufficiently flexible to meet the varying conditions which exist. Where limits for polluting wastes are given in the following paragraphs, they are to be considered as the maximum permissible for a minimum quality of water. They will serve as guides in determining pollution abatement control measures. More restrictive limits may be required if consideration of all factors at specific locations shows that a higher quality of water is needed in the public interest.

In considering water quality objectives, pollution may be classified on the basis of effects on water quality as follows: bacterial contamination; deoxygenation; toxicity; taste and odor; color; undesirable pH conditions; suspended solids and floating material; excessive dissolved solids; and high temperature.

Bacterial

Bacterial quality is definitely pertinent to the uses of water for public water supply and for recreational purposes. Bacterial pollution usually is associated with domestic sewage. This is understandable by reason of the disease organisms that may be contained in human excretions. However, bacterial increases are coincident with organic decomposition and bacterial concentrations will vary with organic content and with stages of deoxygenation and decomposition. The densities of coliform organisms (intestinal bacteria) furnish accepted criteria for the evaluation of public water supplies and recreational waters. The most probable number method of enumeration (MPN) is used by the Indiana Stream Pollution Control Board. The Ohio Department of Health is prone to use the indicated number (IN) based on Phelps Index values, as a time saving procedure. Although the two methods of calculation are different and although identical numerical indices are not obtained when they are applied to the same data, the differences in values obtained are of minor significance. For all practical purposes the use of either method as an index of pollution furnishes a satisfactory basis for establishing waste treatment requirements to protect public water supplies.

At water works intakes on streams of the Maumee River Basin the monthly arithmetical average of "most probable numbers" or, as an alternate, of "indicated numbers" of coliform organisms should not exceed 5000 per 100 milliliters (5000 per 100 ml.) in any month; nor exceed this density in more than 20% of the samples of such waters examined during any month; nor exceed 20,000 per 100 ml. in more than 5% of such samples. It is felt that, if coliform reductions are accomplished to attain such quality, accepted practices of water treatment will assure safe public supplies.

Meeting the objective for public water supplies at existing intakes will assure satisfactory bacterial water quality for certain recreational uses in protected stream zones and may assure water quality suitable for bathing or swimming in a few stream areas. For non-bathing or non-swimming recreation the monthly arithmetical average of "most probable numbers" or of "indicated numbers" should not exceed 5000 per 100 ml. in any month of the recreational season, nor should exceed this number in more than 20% of the samples examined during such month. For bathing and swimming waters the monthly arithmetical average of "most probable numbers" or of "indicated numbers" of coliform organisms should not exceed 1000 per 100 ml.; nor should exceed this number in more than 20% of the samples examined in such month; nor should exceed 2400 per 100 ml. on any one day. It must be emphasized, however, that even though all bacteria from sewage pollution were to be removed, other factors beyond the control of water pollution control agencies may still make waters of the inland streams of the basin unsuitable for bathing. Careful consideration must be given to natural, public health, and economic factors in justifying the application of bathing water quality objectives to waters of the basin.

Deoxygenation

Deoxygenating wastes are usually organic in nature, containing material either in suspension or solution, and may derive from sanitary sewage or from industrial wastes. Where organic pollution is sufficiently great, the oxygen content in the water is depleted; fish and other wildlife are killed or their propagation inhibited; oxidation ceases, and, anaerobic decomposition or septic action increases, with attendant nuisances, disagreeable odors, toxic effects, and public health menaces. Adequate protection of the waters against unreasonable oxygen depletion should result if sewage and industrial wastes are treated sufficiently to obtain substantially complete removal of settleable solids and removal of other organic matter as required to hold the dissolved oxygen content above a critical point. The minimum dissolved oxygen objective for the Maumee River and its tributaries has been established at 4 ppm which, during critical summer conditions, is comparable to 50% dissolved oxygen saturation. This criterion meets requirements

of normal water uses including the protection of fish and wildlife common to the waters of the basin. Exceptions are made where water uses require higher quality.

Toxic Wastes

There are literally hundreds of substances, alone or in combination, which, at critical concentrations, are toxic to humans, to animals, and to fish and other wildlife. The toxic effects may range from serious conditions affecting public health or causing direct fish kills to minor disturbances which may be serious only over a long period.

The chemical characteristics, or mineral content, of the receiving water has a great influence on the toxicity of individual pollutants to fish and other aquatic life. Also concentrations of certain substances, considered individually, may not be serious, whereas they may be quite injurious in combination with other substances.

In some instances concentrations of toxic materials, not sufficient to cause direct kills of fish but inimical to their propagation, possibly may be tolerated in short, most critical, stream sections. Concentrations causing direct kills will not be permitted in any streams of the basin.

The above discussion results in the conclusion that it is impractical to fix definite limits on concentrations of toxic substances. The general objective will be to eliminate or prevent concentrations which will be unduly injurious to the reasonable and necessary uses. Insofar as fish and other aquatic life are concerned determination of whether or not the objective is being met will be based on biological indices of pollution. Application of toxicity limits to protect fish and other aquatic life will generally provide satisfactory protection for other water uses. Should there be exceptions, limits will be based on the specific uses affected.

Although, as mentioned above, there are many substances and combinations of substances which are toxic, it is likely that a great many of these will not be discharged to the streams in sufficient quantity to be a problem, possibly because such wastes are not normally found in the basin or because their value tends to preclude their discharge as waste products. However, some substances were encountered during this investigation which are troublesome to certain uses in concentrations above certain limits. Occurrence of these substances above such limits will be prima facie evidence that excessive pollution exists. Pending the results of studies and research now in progress by qualified technical groups, the following should serve as a guide to the reasonable protection of the waters of the basin:

	Parts per million (ppm)
Cyanide (as CN)	not over 0.15
Lead (as Pb)	not over 0.35
Copper (as Cu)	not over 0.4
Chromium (hexavalent) (as Cr)	not over 2.0
Cadmium (as Cd)	not over 0.4
Zinc (as Zn)	not over 1
Nickel (as Ni)	not over 5
Nitrate (as N)	not over 10

It is emphasized that exceptions to the above must be made where water uses require higher quality; and, further, that some of the above substances may cause damages in lower concentrations than noted under certain conditions and in certain combinations.

Taste and Odor

In general, wastes producing tastes and odors shall be limited to the extent required to prevent undue damage to reasonable and necessary water uses.

Probably the most prevalent offensive wastes from the standpoint of taste and odors are the phenolic wastes from coke, synthetic resin, synthetic fibre, synthetic rubber, oil refining, petroleum cracking, tar, road oil, creosoting, wood distillation, and dye manufacturing industries. Treatment shall be given to wastes containing phenols, oils, and allied derivatives to obtain substantially complete removal of these substances at their source.

Color

Discharge of color producing substances which impair reasonable and necessary water uses will not be permitted.

At least partially pertinent to this category are iron and manganese. The concentrations of each of these substances shall not exceed 5 ppm (as Fe and Mn, respectively). This objective will provide reasonable protection for all water uses.

pH

No substance will be permitted which will cause the pH of the receiving water to fall outside a pH range between 6.3 and 9.0. This will provide general protection to public water supplies, to industrial water supplies, to fish and other aquatic life, and to other uses.

Suspended Solids and Floating Materials

Substantially complete removal of settleable solids and floating materials will be required to prevent nuisance conditions and sludge deposits. Additional removal of suspended solids may be required to prevent turbidity causing excessive damages to water uses.

Dissolved Solids

Objectives concerning damages from dissolved solids related to toxicity, oxygen depletion, taste and odors, pH, and color are discussed under these effects. Additional limitations on dissolved solids will be applied to prevent excessive hardness or other damaging effects. Chlorides (as Cl) should not exceed 100 ppm at any location within the basin.

Temperature

Operations resulting in excessive stream temperatures which impair other water uses, reasonable and necessary in the public interest, will not be permitted.

Fluorides

Although some ground waters of the basin have significant fluoride content, requiring correction to come within acceptable limits for public water supply purposes, there is no indication at this time of adverse influence of fluoride-bearing wastes on surface waters. In case control of these wastes becomes necessary the maximum tolerable at water works intakes is fixed at 1.5 ppm.

Special Conditions

Insofar as practicable the effect of sewage or waste discharges on the receiving waters shall be considered after they are mixed with the waters and beyond a zone of immediate effect. The extent to which this is practicable depends on local conditions and the proximity and nature of other water uses.

Where limitations on waste discharge are determined by public water supplies and where these limits are more restrictive than for other water uses, the objectives shall be applied to conditions at the water supply intakes.

Every effort will be made by the regulatory agencies (1) to preserve the present cleanliness of basin waters and (2) to improve the water quality insofar as such action is consistent with the public interest. Objectives as offered, therefore, do not invite the loading of waters to the maximum allowable but do serve as a guide to a sound pollution abatement and control program.

ACQUISITION AND PRESENTATION OF SURVEY DATA

Extent of the Survey

Investigation of the sanitary quality of the waters of the Maumee River Basin necessitated a study of the sources of pollution in the drainage area. In pursuance of these studies an extensive survey was carried out by personnel of the Water Pollution Control Unit, Sanitary Engineering Division, Ohio Department of Health in the Ohio section of the basin and by personnel of the Indiana State Board of Health in cooperation with the Indiana Stream Pollution Control Board in the Indiana section of the basin.

To determine the significant contributors of pollution, a systematic investigation of every possible source, both industrial and municipal, was conducted. This procedure involved the determination of the volumes and characteristics of all industrial wastes and sewage, either treated or untreated, that were being discharged to the waters of the drainage basin. This information, together with other pertinent data, provided a basis for analyzing the pollution load of any incremental area and of the entire basin.

The survey entailed a program of stream sampling from the mouth of the Maumee River and extending throughout the major streams in the watershed to the upper reaches of the river with particular emphasis on those streams receiving significant pollution loads. A total of 297 stream sampling stations were established in the Ohio section of the basin and a total of 49 sampling stations in the Indiana section. The samples collected were analyzed in the field for dissolved oxygen (D. O.) both in the Ohio and Indiana surveys. Other analyses of Ohio samples were made in the Ohio Department of Health mobile laboratory located in the near vicinity or when required further analyses were conducted by the Division of Laboratories of the Ohio Department of Health in Columbus. Analyses of Indiana samples, other than D. O. determinations, were accomplished in the laboratory of the Indiana State Board of Health at Indianapolis. Samples were iced and shipped daily by bus or truck to the laboratory. Chemical and bacteriological analyses were performed on all stream samples in Indiana. In Ohio chemical analyses were performed on stream samples while bacterial data were obtained from current operation reports of water works operators, submission of which is required at monthly intervals by the Ohio Department of Health, and from the Lake Erie pollution study supervised by the Ohio Department of Health during 1950 and 1951.

Organization of the Survey

The field studies of the Maumee River Basin survey began in Ohio in July and continued into November of 1950. Additional field data were collected in October, 1951. During the period July to September, 1950, Indiana conducted field studies in the Indiana section of the basin; however, certain industries in Indiana had been surveyed prior to this period. On September 11, 12, and 13, 1950, simultaneous stream surveys were made of the St. Marys River, St. Joseph River and Maumee River by field crews of the States, each covering portions of the streams within the respective States. D. O. determinations were made at selected sampling points at intervals of 3 to 4 hours during a 24-hour period; also, samples were composited over a 24-hour period for determinations of biochemical oxygen demand (B. O. D.).

Field personnel of the survey in Ohio generally consisted of five engineers, one chemist, and two field assistants. The Indiana party was made up of an engineer and four assistants.

The Ohio area of the Maumee River Basin was divided into five sections, generally in accord with major tributaries, for convenience in the prosecution of the field work. The Indiana area was divided into three sections generally coinciding with the main stream and two major tributaries.

Location of Sampling Stations

Tentative locations of the stream sampling stations were established by cursory examinations of topographical, road, and drainage maps prior to the start of the survey. The final sampling points were established after inspections and after initial runs that reflected influences of significant pollution. Bridges were used as much as possible. Sampling stations were located with three main objectives in mind, (1) to give a representative picture of the pollution conditions existing in the stream, (2) to conserve time and effort, and (3) to choose stations conspicuously marked so as to be easily located on maps as well as in the field. Fortunately, bridges were available in most places. However, in the lower reaches of the Maumee River virtually all the stations were sampled from a boat.

Figure 3 of the appendix shows the location of the main sampling points. These are designated on the streams sampled by abbreviations of the stream names followed by numbers in sequence.

Method of Sampling

Sampling operations were conducted in accordance with the procedures

and methods outlined in Standard Methods for Examination of Water and Sewage, ninth edition, published jointly by the American Public Health Association and the American Water Works Association. Every practical precaution was taken to assure the collection of samples that represented the actual quality of the material being sampled.

The methods of sampling were varied to fit individual conditions and the types of material being sampled. These fell into three categories; namely, industrial wastes, municipal sewage, and stream water.

Industrial sampling followed the general plan of the collection of a representative sample over a sufficient period of time to give an accurate picture of the characteristics of the wastes. At the same time flow measurements were made and the sample composited in proportion to the flow. Sampling periods varied from about 8 hours to 24 hours in length with samples collected at 1/2 to 1 hour intervals. A sufficient number of samples were collected at each sampling point to be indicative of the wastes discharged. Magnitude of flows were determined by the use of meters or weirs, by measuring the time required to fill a container of known capacity, or by calculations using the cross-sectional area of flow and velocity, the latter value computed from the hydraulic gradient.

The procedure followed in the sampling of municipal sewage was dependent upon the type of sewerage facilities serving the municipality. Where all sewage and industrial waste was treated at a sewage treatment plant, samples were collected only at the plant. Where part of the sewage was treated and part untreated, both were sampled. Where there was no treatment, samples were taken from all sewers discharging to the streams or other waters. The sampling procedure at sewage treatment plants was substantially the same as that at industries with the exception that composite samples were taken of the raw sewage as well as of the final effluent and in some cases of the effluents of intermediate treatment facilities.

Special equipment was utilized to collect stream samples in conformity with standard procedures. Collecting devices prevented aeration of D. O. and B. O. D. samples while they were being collected. Apparatus and chemical reagents in appropriate field kits were used by the survey crews of both States for the Determination of D. O. at the time of sampling. In Ohio the sample for B. O. D. determination and other analyses was siphoned from the container to a B. O. D. bottle or carrying bottle for transit back to the mobile laboratory. In Indiana the B. O. D. samples, either catch or composite over a 24-hour period, were shipped to the laboratory in Indianapolis. In all stream surveys pertinent data relative to odor, color, algae, floating solids and other physical features of the stream were recorded at time of sampling as were water temperature and D. O. value.

Analytical Procedure

All chemical, biological, and bacteriological analyses of samples collected were performed in accordance with Standard Methods for Examination of Water and Sewage. Routine chemical and physical determinations on the majority of sewage and industrial waste samples comprised temperature, pH, alkalinity, chlorides, D.O., 5-day, 20° C. B.O.D., total solids (total and volatile), suspended solids (total and volatile), and settleable solids.

In addition to the above routine examinations, nitrates, nitrites, phenols, cyanides, oil, iron, various other metals, and other determinations were made on samples where the characteristics of a particular sewage or industrial waste indicated the need for further definition.

Throughout this report quantities of organic wastes have been expressed as "population equivalent." Extensive research has shown that the average 5-day, 20° C. B.O.D. per capita for average municipal (domestic) sewage is 0.167 pound per day and this factor has been used to convert industrial waste loads to population equivalent, which is readily understood. All values for population equivalent appearing in the report are based on 5-day, 20° C. B.O.D., unless otherwise designated.

METHODS USED FOR ANALYSIS OF STREAM CONDITIONS AND NECESSARY REDUCTION OF ORGANIC POLLUTION LOAD

An evaluation of the factors influencing the self-purification capacity of a river is essential in the determination of the quantity of pollution abatement necessary to meet the requirements for intended water uses. At the present time the best single measure of sewage and organic industrial waste pollution is the quantity of oxygen required to stabilize this pollution. The combined effect of the utilization of the dissolved oxygen (D. O.) from the river water by the polluting substances and the subsequent reaeration of the water by atmospheric oxygen has frequently been studied through the medium of a graph called the "oxygen sag" curve in which the D. O. is plotted against time. The term sag is characteristic of the form of the graph in that the curve descends from an initial dissolved oxygen content to a minimum point marking the critical zone of oxygen depression in the stream and then turns upward toward the complete oxygen saturation point.

No mathematical approach to the rates of deoxygenation and reaeration is applicable to streams in which the D. O. is entirely depleted by reasons of oxygen demanding properties of sewage and industrial wastes; positive D. O. values are essential. Furthermore, mathematical formulas are not applicable when oxygen supersaturation occurs. Consequently in stream areas or in small tributary streams of the basin in which these conditions were experienced, required reductions in waste loads are based on experience on other streams, including those stream areas for which the survey data are subject to mathematical analysis.

In stream areas where significant deoxygenation and reaeration could be expected, the field work was planned initially to collect data which would be applicable to the LeBosquet [1]/ method of estimating the necessary degree of pollution reduction. The method had been used in the Water Pollution Study of the Miami River (1949); had been checked with other methods requiring more detailed compilation of data, more detailed mathematical computation or more detailed correlation of probability factors; and had been considered satisfactory for Miami River conditions.

---

[1]/ Maurice LeBosquet, Public Health Service, Federal Security Agency, Simplified Dissolved Oxygen Computations, Sewage and Industrial Wastes, Volume 22, No. 8, page 1054.

During the 1950 period of the Maumee River investigation erratic oxygen depletion data were attributed to stream flows which were much above the drought range. Although flows of the late summer and early fall of 1951 approached drought conditions, the application of the D. O. values obtained to the LeBosquet method gave erratic results. Examination of all data indicated that a number of fluctuating factors can be reflected in the computations. The nature and degree of these effects are not precisely known. The factors included physical features, such as dams; variations in pollution loads applied to the stream; variation in stream flows induced to some extent by counter current action in pools behind dams, and probably accompanied by variations of the effect of the applied loads on the stream (i. e. settling of suspended solids during decreasing flows and disturbances of sludge banks during increasing flows); effects of sludge accumulations behind dams; variations in D. O. content immediately above points of major pollution, indicating variable residual biochemical oxygen demand (B. O. D.) content in the stream from upstream sources and hence a greater pollution load in the stream than presumed present by the measurement of applied loads (the stream B. O. D. being determined only infrequently by reason of the initial plan to use the simplified method); and evidence of photosynthesis by the presence of oxygen supersaturation in upper water layers in some instances.

Carefully selected data applied to the LeBosquet and Streeter-Phelps [2/] formulas, respectively, gave comparable values of essential pollution reduction. Observations gave assurance that the calculations, though leaning toward a conservative approach, furnished a framework upon which a practical evaluation of stream conditions at critical flows can be made. Pollution reductions as determined will tend to eliminate some of the troublesome variable factors and to render the stream conditions more amenable to future sanitation studies.

2/ H. W. Streeter and E. B. Phelps, Public Health Bulletin 146, U. S. Public Health Service, 1925.

SECTION II
DETAILS

DESCRIPTION OF MAUMEE RIVER BASIN

Geography

The Maumee River, a tributary of Lake Erie, drains an area of 6,586 square miles, of which 4,856 square miles are in Ohio, 1,260 square miles in Indiana, and 470 square miles in Michigan. The Maumee River has its source at Ft. Wayne, Indiana, where its two major tributaries, the St. Marys and St. Joseph Rivers, come together. From its head at Ft. Wayne to its mouth in the western end of Lake Erie the Maumee River is about 128 miles long and has a total fall of about 165 feet, an average fall of 1.3 feet per mile. That part of the Maumee in Ohio is about 103 miles in length.

The St. Marys River, originating in Shelby County, Ohio, flows northwestward for about 100 miles with an average gradient of approximately 2.5 feet per mile. The St. Joseph River, also about 100 miles long, has its origin in Hillsdale County, Michigan, and flows across the northwest corner of Ohio, entering Indiana about 35 miles northeast of Ft. Wayne. The St. Joseph has a gradient of about 3.1 feet per mile.

Two more large tributaries join the Maumee River at Defiance. The Tiffin River enters from the north, the Auglaize from the south. The Blanchard and Ottawa Rivers are important tributaries of the Auglaize River.

Figure 1 of the appendix is a map of the Maumee River watershed, showing the drainage area, rivers and tributaries, and principal population centers.

Physiography

The Maumee River Basin is a glaciated area characterized by low relief and glacial till. The basin is located entirely within the Central Lowland province of the Interior Plains physiographic division. The southern part lies in the Till Plains section while the northern part is in the Eastern Lake section, with the boundary between the two sections extending roughly east and west through Ft. Wayne. [1]

---

[1] N. M. Fenneman, Physiographic Divisions of the U. S., Annals of the Assoc. of Amer. Geographers, vol. 18, 1928, pp. 261-353.

These two sections of the Central Lowland province are much alike superficially. Both have extensive areas of glacial till plains, but lake plains are characteristic of the section on the north and are wholly absent from the section on the south. [2] The Maumee River dissects the extremely flat lacustrine plain that in preglacial times was part of the floor of ancient Lake Maumee. To the north and west of the lake plain, the peripheral tributaries of the basin lie in till plains of the Eastern Lake section; to the south, in the till plains of the Till Plains section.

Geology [3]

The Maumee River Basin is located west of a huge anticline known as the Cincinnati Arch. Silurian, Devonian, and Mississippian rocks lie in series with the youngest to the west. Much of the area is overlain with glacial drift and sedimentary deposits from ancient Lake Maumee. Several stages of glacial lakes have marked the area with prominent beach ridges.

Ground Water Storage in Relation to Stream Flows

The limestone bedrock of the basin has little direct influence on stream flow. The surficial deposits on the bed of ancient Lake Maumee are generally fine sand, silt, and clay. All are relatively impermeable. However, occasional deep deposits of relatively permeable sand are found. Beach ridges, the remains of several glacial lake stages, are generally of permeable sand, but shallow with no great effect on stream flow. The till plains are more permeable; however, the deposits of permeable materials are not extensive. The major portion of the dry-weather flow comes from the permeable till plains. Consequently, the dry-weather flow, in terms of yield per square mile, is much greater near the headwaters of the tributaries than for the Maumee River proper.

The highest dry-weather flow indices are found on the St. Joseph River and Bean Creek, a tributary of the Tiffin River. No stream in the basin has a high sustained flow. The stream flow in the entire basin may be considered as only fair or poor when compared with other nearby drainage

---

[2] N. M. Fenneman, Physiography of Eastern U. S., p. 456, McGraw-Hill, 1938.

[3] Ohio Stream-Flow Characteristics, Part 1, Flow Duration, Ohio Dept. Nat. Resources, Div. of Water, Bulletin 10, p. 31, Sept. 1949.

basins. Not only are the low flow indices in the basin low, the median and high flow indices are also relatively low. 4/

Water Development

The Wabash Canal was built in 1837 along the Maumee River from Toledo to Defiance. The section formed a portion of the Miami and Erie Canal built a few years later. Grand Reservoir (Lake St. Marys) was formed in 1841 by damming the headwaters of the St. Marys and the Wabash Rivers and flooding the water across the divide between them. The canal system is now abandoned, but the reservoir is still maintained, and water flows in some short reaches of the canal. Today navigation in the basin is unimportant except in the lower Maumee River at Toledo.

Available heads in the basin are generally too low for profitable water power, and except for the three hydroelectric plants mentioned in this report under water uses, there has been little development in this respect.

Considerable dike construction has been completed by the city of Ft. Wayne. The dikes provide some measure of flood protection for the city. Dikes have also been constructed by local interests in the Bean Creek area for the control of spring freshets.

Population

Based on the 1950 census figures, the population of the Maumee watershed was about 948,600. Ohio had 698,600; Indiana 223,400; and Michigan 26,600 inhabitants; or approximately 74, 23, and 3 percent, respectively, of the total for the basin. The Ohio figure includes the entire population of Toledo. Though this city is only partly within the basin, its waste disposal facilities discharge to the Maumee River. For this reason, all of Toledo is considered to be within the basin for purposes of this study.

The average population density of the Maumee River Basin is approximately 144 persons per square mile. About 689,800, almost three fourths of the total, are concentrated in 129 incorporated cities and towns. This population of incorporated communities includes all such places listed in

---

4/ Ohio Stream-Flow Characteristics, Part 1, Flow Duration, Ohio Dept. Nat. Resources, Div. of Water, Bulletin 10, p. 32, Sept. 1949.

the 1950 report of the Bureau of the Census. 5/ Of this population in incorporated places, 487,469 are found in the three cities of Toledo and Lima, Ohio, and Ft. Wayne, Indiana.

Table 1 and figure 4 of the appendix show population growth trends in the basin. The curve showing the combined population of incorporated cities and towns reflects the urban population trend. The lower curve, which represents all population not residing in incorporated places, reflects the rural trend. The population classification used in developing the curve does not completely differentiate between urban and rural population as defined by the Bureau of the Census. The incorporated-unincorporated classification is used because it results in more comparable data for the various census report years than does the urban-rural breakdown. Use of the latter classification is discouraged by changes which have been made in the official definition of urban population.

For stream pollution considerations, it is important to know the population of communities which discharge wastes to the streams. The State water pollution control agencies have listed 69 such cities and towns. All except two of these are incorporated communities with a combined population of about 659,500. The two unincorporated places listed have a combined population of 2,800. Thus the total population of all communities which are now contributing significant pollution to the surface waters of the Maumee River Drainage Basin is estimated to be about 662,300. The 1950 population of each listed community is shown in table 5 or table 6 of the appendix.

The distribution of population of municipal sources of pollution by subwatershed areas is shown in table 2 of the appendix.

Industry

The Maumee River Basin is an important agricultural area, but manufacturing is of considerable significance in the larger cities.

The greater portion of the land of the basin is under cultivation. Diversified farming, dairying, and some stock raising are practiced. Industrial activities in the basin are also varied. Manufactured products include locomotives, automobiles and trucks, machinery, electrical equipment, tools,

---

5/ U. S. Census of Population: 1950, Vol. I, Number of Inhabitants, U. S. Bureau of the Census, Washington, D. C., 1951.

processed foods, and many others. Oil fields in the eastern portion of the basin have passed their peak of productivity, but wells are still pumped periodically. Natural gas, produced in substantial quantities in the area, is piped to metropolitan centers for domestic and commercial consumption. Lima, Ohio, is the center of an oil distribution system with pipelines extending from the oil fields of Wyoming, Texas, and Oklahoma to the Great Lakes and eastern markets. Toledo, Ohio, is a railroad center and a very important coal shipping point.

HYDROLOGICAL DATA

The factor of critical low flow is one of the most important factors to be considered when making a study of a stream to determine the pollution loads which can be absorbed without violating an established water quality objective. Accordingly, in selecting critical stream flows, much consideration has been given to criteria which are reasonable and justifiable. The critical flows selected are the stream flows which the regulatory agencies consider as a minimum for use in the design of sewage and industrial waste treatment facilities.

Stream flows experienced in the Maumee River and its tributaries during the 1950 field survey were three or four times those normally experienced. In the late summer of 1951 flows more nearly approached, but never reached, drought proportions. Even so, on tributary streams the effects of pollution loads could be observed satisfactorily and conclusions drawn with little difficulty. On the main stem of the Maumee River, however, it was not so easy. Physical features, such as dams, and relatively high flows interfered with satisfactory observations relative to the response of the river to pollution loads under drought conditions.

A thorough study of all flows of record was made at key U. S. Geological Survey stations located within the basin. These stations were on the St. Marys River near Ft. Wayne, the St. Joseph River near Ft. Wayne, the Tiffin River at Stryker, the Auglaize River near Ft. Jennings, the Blanchard River near Findlay, the Maumee River at Waterville, the Maumee River near Defiance, and the Maumee River at Antwerp. Flow records extended over periods ranging from 9 to 35 years at the several stations.

Frequency curves were developed from records of respective gaging stations to show the percent of years when minimum monthly averages, minimum seven-consecutive-day averages, and minimum daily flows were greater than those shown. Conversely, the curves show the percent of years when the specified minimum flows were equal to or less than those shown. Figure 5-E in the appendix is a typical curve. It will be noted that for 80 percent of the years the minimum average monthly, the minimum average seven-consecutive-day, and the minimum daily flows equaled or exceeded 170, 112, and 70 cubic feet per second (c.f.s.), respectively. Conversely, in 20 percent of the years flows were equal to or less than these values.

Flow-frequency values indicated on the curves are a measure of probability and do not infer that there will be occurrences of low flows in regular sequences or at regular intervals. However, together with other data, they serve as a basis for analyzing flow conditions in the basin and selection of "critical" flows to be used in determining required reduction of pollution loads. Consideration of frequency and period of duration of low flows in relation to effects of pollution and economic factors prompted the selection of a "critical" flow based on the minimum seven-consecutive-day average which can be expected to be equaled or exceeded in 80 percent of the years. The selected flow criteria appear satisfactory for conditions in this basin and should afford reasonable protection for essential water uses.

Table 3 of the appendix is a list of critical flows at gaging points computed in accordance with the selected criteria. Yield per square mile were also computed from the critical flow and the tributary drainage area. It will be noted that there is considerable variance in the yield at various locations. For instance, the yield of 0.0612 c.f.s. per square mile for the St. Joseph River near Ft. Wayne indicates that there must be considerable recharging of the stream from underground storage. Comparatively, the yield of the Blanchard River at Findlay is low and is typical of the conditions at the headwaters of this stream. This indicates little recharging from underground storage.

Critical flows established at gaging stations, in terms of yield per square mile, were used in computing critical flows at other focal points of pollution for use in determining requirements for waste load reduction. Data from gaging stations best representing conditions at the focal points were used in the computations. It should be noted that this method of computation will probably result in flow values somewhat at variance with those actually occurring, particularly on the smaller tributaries. Generally, such variance would not be great enough to effect the degree of treatment selected.

In this connection, attention is called to the fact that, for a large percentage of the focal points of pollution on the tributaries, the highest degree of treatment practicable is required. This requirement is obvious because of extremely low flows in relation to pollution loads. In such cases precise determinations of critical flows or detailed mathematical analyses of stream purification characteristics are not necessary.

WATER USES

The surface waters of the Maumee River basin are used for domestic and industrial water supply, livestock watering, fish and wildlife propagation, recreation, navigation, hydroelectric power, and for the disposal of municipal and industrial wastes.

The use of surface waters for public water supplies is one of the most important water uses in the basin. Table 4 of the appendix lists the public water supply systems in the basin. These data show that there are 75 public water supplies serving 77 municipalities and 2 sewer districts. These 79 population centers have a total population of 707,300. Although Toledo obtains its water from Lake Erie, it is included because the quality of the raw water for this supply is affected by pollution entering the Lake from the Maumee River. This system serves a population of about 300,000 including two small municipalities and sewer districts in Lucas and Wood counties. The latter also discharge their sewage to the Toledo sewer system. Bowling Green (population 12,005), located outside the drainage area, but obtaining its water supply from the Maumee River, is also included. Further study of the table shows that 14 water treatment plants serving 16 municipalities and 2 sewer districts, total population 591,500, obtain water from the Maumee and its tributaries or from surface waters affected by pollution originating in the drainage basin. Thus 84 per cent of the municipal population served by public water supplies depend upon surface waters for this vital necessity. Although a larger number of the municipalities in the basin obtain their supplies from wells, these are the smaller communities with relatively low daily requirements. The fact that the largest city in the basin depending entirely on ground water is Decatur, with a population of only 7,271, reflects the limited yields to be expected from underground aquifers. The chemical quality of such waters also is generally inferior to that of surface waters in the basin. Thus it is quite apparent that the surface waters of the basin must be depended upon to furnish the water supply of an increasing number of municipalities. These facts emphasize the importance of preserving and protecting this high priority water use.

The surface waters of the basin are also important for industrial uses. Considerable quantities of water are furnished to industry by municipal water supply systems. In addition, there are many separate industrial water systems. Water is an important raw material in many manufacturing processes and large quantities are also required for cooling and other uses.

Not only quantity, but quality as well, must be considered in water used for most industrial processes. The chemical specifications for industrial water are often more rigid than for domestic water. Here again, because of the limited quantity and often inferior chemical quality of groundwater, surface supplies furnish most of the water used by industries of the basin.

Although livestock raising is not the primary agricultural activity within the basin, it is of considerable importance and the use of the streams for livestock watering is widespread.

The potential recreation value of the streams in the Maumee Basin is not fully indicated by the present uses. Pollution of the streams (particularly downstream from large centers of population), low sustained flows in the smaller streams, and high turbidities in some streams, together with the proximity of better quality surface waters along the shore of Lake Erie and in the numerous lakes just outside the basin in Michigan and Indiana, have no doubt exerted retarding influences on the recreational uses of the waters of the basin. However, even under existing conditions, boating, fishing and other recreational uses of the streams are significant.

Boating is a major summer sport, particularly in the area below Ft. Wayne, where thousands enjoy the annual boat regatta each year.

Information from the Indiana State Conservation Department and from the Ohio Department of Natural Resources indicates that fishing is a popular sport in the basin. Bass, catfish, blue gills, and other species of pan fish in significant numbers are caught in waters of the basin.

With a population which is steadily increasing, the potential recreational value of the streams is also increasing. This value will be more fully realized with the attainment of desirable pollution control measures.

Navigation is an important use of the lower reaches of the Maumee. A navigation channel 25 feet deep extends from deep water in Lake Erie to a point seven miles upstream from the mouth of the Maumee River. This channel serves as a connecting link between lake shipping and railroad facilities.

The use of the streams for hydroelectric power development is limited in the Maumee Basin by relatively flat topography. There are three hydroelectric plants in the basin, but they are "run-of-river" plants with little storage. A privately owned hydro-power plant is located on the Auglaize River about three miles above its mouth. With approximately 9,800 acre-feet of usable storage, this plant has a capacity of some 5,000 kilowatts. Two small plants, one at Maumee and another at Ft. Wayne, have a combined capacity of 425 kilowatts.

Not the least important is the use of the surface waters of the basin for final disposal of municipal and industrial wastes. However, the capacity of the streams of the basin to assimilate pollutional substances contained in these wastes, without seriously damaging other water uses, is not without limitation. As pointed out elsewhere, the domestic and industrial wastes from municipalities and from industries having separate sewer outfalls have resulted in serious deterioration of water quality at several locations throughout the basin. This unjustifiable overtaxing of the assimilative capacity of many of the streams has rendered them incapable of meeting the needs of other essential water uses.

SOURCES AND EXTENT OF POLLUTION

The information collected during the stream pollution survey of the Maumee River drainage basin was obtained for two general purposes: first, to determine the extent to which the streams were polluted when viewed from the standpoint of established water quality objectives and, second, to establish the origin, volume, and characteristics of all significant pollution being discharged to the streams.

Wastes Having Significant Biochemical Oxygen Demand.

Data on the sources and extent of deoxygenating wastes are presented in this report in tabular and graphic form. Tables 5 and 6 of the appendix show the population equivalent, before and after treatment, of sewered wastes from each municipality which is a significant source of pollution in the area. Table 7 contains information for industries which are not connected to municipal sewer systems. The focal points of areas in which significant polluting wastes originate are represented by symbols on the map in figure 6. The size of each symbol is proportional to the total population equivalent of municipal and industrial wastes originating in or near the community indicated as a focal point.

Table 9 of the appendix is a list of industries within the basin, classified by type of industry, which discharge significant deoxygenating wastes into the surface waters. The data obtained do not permit such classification of all organic industrial wastes originating in the basin since industrial wastes tributary to municipal sewer systems were included in the municipal sewer studies and were not usually investigated separately. Table 9 includes only those industries discharging wastes to the streams which are not connected to municipal sewer systems.

Significant pollution is contributed to the surface waters from 11 sewered cities and towns in the Indiana portion of the Maumee River Basin and from 49 in the Ohio portion. Based on 1950 Bureau of Census data, about 161,100 persons resided in these Indiana communities and 493,800 resided in those in Ohio. Wastes from the sewered communities, including wastes from industries connected to the municipal sewer systems, have a total estimated population equivalent before treatment of about 902,500, of which 158,500 originated in Indiana and 744,000 in Ohio. Treatment of municipal wastes in Indiana reduces the load to about

43,700, a reduction of 73 percent. In Ohio, the load is reduced to about 445,700 by treatment, a reduction of 40 percent. Thus the total load in both States is reduced to about 489,400, an over-all reduction of 46 percent.

As indicated in table 6 of the appendix, pollution load values for some of the Ohio communities are based on loads anticipated after more complete sewer service for the existing population. Both existing loads and loads to be expected with more complete sewer service are given for some of the Indiana communities. The foregoing summary of pollution loads is based on more adequate sewer service.

In addition to the sewered communities discussed, there are several small communities in the basin which now have public water supplies but are not served by a comprehensive system of sewers. The effects on the streams of sewage pollution from these places are of little consequence at the present time. If and when such places are sewered, provision of sewage treatment will be required. Table 6 lists these communities and indicates the potential pollution load which could be expected should comprehensive sewer systems be provided. There are three such places in Indiana with a total 1950 population of 3,349, a present waste load of about 150 population equivalent, and an estimated potential load, based on present size, of about 3,010 population equivalent. In Ohio there are six such places with a total 1950 population of 3,990 and an estimated potential load of 3,650.

There are 51 industries in Ohio not connected to municipal sewerage systems which are sources of deoxygenating wastes. The population equivalent of wastes from these industries before treatment is estimated at about 512,200. After reduction by treatment or satisfactory retention and controlled release from lagoons the load is estimated at about 461,800. In Indiana there are 9 such industries having loads of 29,800 and 23,100, before and after treatment, respectively. As indicated by table 9, where satisfactory holding lagoons with controlled discharge during high flows are provided, waste loads to the streams are not included in the tabulation on the assumption that none are contributed during critical flow periods.

The load discharged to streams includes a population equivalent of about 128,000 contributed by canneries during the canning season only. The canneries are engaged principally in the processing and canning of tomatoes. The length of time the canneries are in operation depends largely on the length of the tomato harvest season, which usually covers a period of about 40 working days in late summer.

The total industrial waste load from both States before treatment is about 542,000 and after treatment or lagooning and controlled discharge, about 484,900. The reduction of loads in Indiana is about 23 percent and in Ohio about 10 percent. The over-all reduction in both States is about 10 percent.

The deoxygenating wastes originating at Ohio municipalities and industries have a total population equivalent before reduction by treatment of about 1,259,800 and after treatment about 911,100. For Indiana the loads are 191,300 and 69,800, before and after reduction, respectively. These loads include those which could be expected if communities having public water supplies but no comprehensive sewer system and those needing sewer extensions should provide new or more complete systems. The over-all reduction of loads in Ohio is 27 percent and in Indiana 64 percent.

The survey information indicates that industries not connected to municipal sewer systems are responsible for about 37 percent of the total deoxygenating waste load before treatment and 50 percent of the load as discharged to the streams. For purposes of stream pollution control, the regulatory agencies consider that industrial wastes discharged into a municipal system are the responsibility of the municipality.

The total deoxygenating waste load in the basin from both municipalities and industries before reduction is estimated at about 1,451,100 and after reduction at about 980,900, an over-all reduction of about 32 percent.

Wastes Causing Bacterial Pollution.

Control of bacterial pollution resulting from discharge of sewage is of particular concern for the protection of public water supplies. Accordingly, requirements for reduction of bacterial loads are directed primarily at such protection. An exception is the Toledo area where a high degree of treatment, with disinfection, is required for the protection of the Lake Erie bathing beaches as well as for protection of the Toledo water supply. In other stream areas protection of public water supplies may result in restoration and maintenance of a quality of water suitable for bathing as an incidental benefit.

In view of the primary purpose in control of bacterial pollution, indices of such pollution are based on water plant records, supplemented by analyses of samples collected during the Lake Erie Pollution Survey from the lower Maumee River in the Toledo area. Pertinent data are summarized in table 8 of the appendix.

The water supplies for Lima, Findlay, Van Wert, Wauseon, Swanton, Delta, Archbold, and Weston are obtained from either impounding or

upground reservoirs filled from tributaries of the Maumee River. Records indicate that the bacterial quality objective is not violated in any of these supplies. The water supplies for Defiance, Napoleon, Bowling Green, and Waterville are obtained from the Maumee River. At the Defiance and Napoleon intakes the bacterial quality objective was violated many months during the tabulated period of record.

The Defiance intake apparently is influenced by local conditions under certain circumstances. The waterworks intake is located upstream from Defiance in a Maumee River pool formed by the Independence Dam. The intake is at a point just above the confluence with the Tiffin River. The Auglaize River also enters the pool a little over a mile below the Tiffin River. The Tiffin River carries slaughterhouse waste and sanitary waste having appreciable bacterial and deoxygenating significance. Numerous sanitary sewers from the city discharge directly to the Maumee River. Under certain conditions, such as a northeast wind, high runoff from the Tiffin River or the Auglaize River, or a combination of these factors, there may be a reversal of flow in the pool which could carry Tiffin River water or the discharge from Defiance sewers to the waterworks intake. Proper collection and treatment of sewage and wastes from the Defiance area should eliminate the possible effect which local sources of pollution have on the intake. Inasmuch as a proposed outfall sewer will probably discharge to the pool above Independence Dam, chlorination of the effluent will serve as a factor of safety to the Defiance waterworks intake.

The bacterial quality of the Maumee River at Napoleon is influenced by wastes from the Defiance area approximately eighteen miles upstream. The effect under existing conditions justifies the requirement that chlorination facilities be provided to disinfect the effluent from the proposed municipal sewage treatment plant for Defiance.

The extent of bacterial pollution at the Bowling Green and Waterville waterworks intakes has not been thoroughly defined. To insure satisfactory quality for these public water supplies, it is considered good practice to require sewage chlorination equipment and facilities as a part of the sewage treatment works at Napoleon.

Extremely high coliform concentrations were found in the lower Maumee River. Chlorination of the effluent from the Toledo sewage treatment works is practiced during July and August to improve water quality during the time of maximum use of the harbor and bayfront area for recreational activities. During the time chlorination is practiced the coliform concentration is materially reduced from the extremely high values found during other months, but not to a value within the proposed bacterial quality objective for recreational purposes. The Toledo

waterworks intake located in Lake Erie about twelve miles east of the mouth of the Maumee River is influenced by the coliform concentration in the river water. The influence is sufficient to make the coliform index higher than that found at many other Lake Erie intakes but not to the extent that the bacterial quality objective is exceeded. Proper collection and treatment of all sewage and other wastes from the communities of Maumee, Perrysburg, Rossford, and Toledo, including construction of proposed additions to the Toledo Sewage Treatment Works, will materially reduce the bacterial load presently imposed on the lower Maumee River.

Wastes Having Other Effects.

Other highly significant substances in industrial wastes which were found being discharged to waters of the basin include toxic materials (from metal finishing plants, oil refineries, and a gas plant); color, taste, and odor producing material (from a blast furnace and by-product coke plant, oil refineries, wood preserving plants, glass fiber plants, and a textile plant); materials which alter the pH of the receiving waters (from metal finishing plants and a textile mill); and suspended and floating material (from oil refineries, a blast furnace installation, a rubber reclaiming plant, and a foundry).

During the course of the survey, samples were collected at all industries discharging significant quantities of wastes in these categories directly to the streams. In instances where it was practicable and where significant results would be obtained, samples of the receiving stream were taken to determine the effect of such discharges on the stream. At each location, however, with the exception of those industries located on the Maumee River proper, the critical flow in the receiving stream is too low to furnish ample dilution of the wastes received.

In all areas an attempt to measure the wastes from sources of pollution other than organic was made at the source, if the wastes were not tributary to municipal sewage treatment plants. It should be realized that samples taken may not reflect average conditions at all industries since many of them, such as electroplating industries, discharge their most offensive material in batches. Since much of the material that is dumped in batches is highly toxic or otherwise offensive, batch discharges should be considered in evaluating data and arriving at conclusions from the information presented herein.

St. Marys Area.

At St. Marys, there are two industries contributing other than organic pollution to the stream. A woolen manufacturing company dumps

a spent dye vat (1500 - 2000 gallons) about every three hours and weekly dumps about 1,000 gallons of strong sulphuric acid solution to the stream. A rubber company, moulding and extruding rubber products and producing Pliofilm plastic, was discharging significant quantities of metals to the stream. Analyses of composite samples showed from 0.27 to 0.52 ppm copper and 261 to 270 ppm zinc in a flow of 833,000 gallons per day. These operating conditions produce high metallic contents and concentrations of batch-dumped dyes and strong acid when discharged to the receiving stream at St. Marys during critical low flow periods.

Bluffton Area

This community has an industry producing plating wastes. The rinse waters are the main source of inorganic pollution. Measurements of flow from this source indicated about 30 gallons per minute of wastes containing cyanides, chromium, cadmium, and copper being discharged to a stream in which the critical flow is very low.

Edgerton Area

One anodizing industry in Edgerton is a source of inorganic wastes. Neutralization is practiced in a holding tank; however, wastes discharged are objectionable because of color characteristics. An average of two 160-gallon dye vats are dumped weekly.

Defiance and Vicinity

There is one industry in Defiance with extensive plating operations. A composite sample revealed discharge of 13 ppm nickel, 15 ppm chromium (total), and 11 ppm chromium (hexavalent). These amounts calculated as pounds per day were: nickel, 7.35; chromium (total), 8.46; and chromium (hexavalent), 6.21. These wastes were discharged through sewers into Preston Run, a stream of very low flows.

A foundry operating in this area was found to be contributing suspended solids to a drainage ditch and subsequently to the Maumee River at a rate of 138 ppm or 921 pounds per day, a suspended-solid population equivalent of 4,600 persons. This condition prevailed despite a settling lagoon in use. Laboratory tests demonstrated that 100 ppm were settleable solids which could be removed in properly designed settling basins.

Lima Area

The principal sources of polluting wastes classified as other than organic in the Lima area are a large refinery and a creosoting company.

Flow data showed the refinery to be discharging about 2,700 gpm from two outlets, with about 90 - 95 percent of the flow being in one outlet. Analysis of samples indicated that wastes from the major outlet contained 14 ppb phenols and 30 ppm oil. A composite sample from this same outlet indicated a settleable solids content of 108 ppm. Wastes from the lesser outfall contained 80 ppb phenols and 114 ppm oil. Since the survey, provisions have been made to collect wastes from the refinery to a central point for treatment in modern oil separator equipment. The effluent is now all discharged through the larger outlet.

A composite sample of waste from the creosoting plant's normal process flow contained 80 parts per billion (ppb) phenols. A composite collected during the process of pulling a vacuum on the creosoting cylinder showed heavy tar emulsions in the wastes.

Discharge of wastes from the above industries was at all times in evidence on the Ottawa River in the form of oil slicks, color, and sludge deposits.

Waterville Area,

The principal source of inorganic pollution in the Waterville area is a company producing spun glass products. The phenolic content of wastes from processes producing phenols is about 32,000 ppb. However, after dilution with wastes from other processes, phenols are reduced to 4,000 ppb as discharged to the Maumee River. The combined wastes from this factory contain 50 ppm settleable solids.

Toledo Area,

Pollution originating in the Toledo area is of major significance in the Maumee River Basin. In this area four large oil refineries and a large blast furnace installation are the principal sources of wastes classified as other than organic or bacterial. The refineries normally process about 155,000 barrels of crude oil per day. Two companies with a combined capacity of 55,000 barrels per day have a common oil-water separator installation. The other two have separate oil-water separators. Analyses of composite samples from refineries reveal average phenol content of wastes from the different plants ranging from 1.0 to 29.1 ppm and average oil content from 5.0 to 55.5 ppm.

Significant quantities of settleable solids were found in the wastes of all four refineries.

The blast furnace installation, producing about 1,275 tons of pig iron a day, was discharging large volumes of liquid wastes from the

various units. Analyses of composited samples revealed high iron content, ranging from 270 ppm for settled wastes from one furnace to 2, 150 ppm for wastes from another furnace discharged without settling. Coke and ammonia still wastes contained phenols ranging from 7. 0 to 33. 6 ppm. All samples from this plant revealed high settleable solids.

Findlay Area

Industries in the Findlay area discharging wastes which are classed as other than organic in character include an oil refinery, a rubber reclaiming plant, and an oil blending plant. The wastes from the last two are relatively small in volume but have suspended solid contents and chemical characteristics which are objectionable. The oil refinery processes about 12, 000 barrels of crude oil per day and manufactures many types of petroleum products. The waste waters at the time of the survey were treated in numerous small inefficient separators, with effluents containing significant quantities of oil. In 1952 the oil wastes were all collected for treatment at a central point in a modern oil separator. All of these industries discharge to the Blanchard River through a small drainage ditch. These industrial wastes exert a marked effect upon the water quality in the small ditch as well as in the Blanchard River during periods of critical flows.

Fort Wayne Area

The amounts of chemical and metallic wastes being discharged to streams in the Fort Wayne area are relatively insignificant with the exception of those going into Harvester Ditch, which empties into the Maumee River at the eastern corporate limits of Fort Wayne. Oil wastes from two industries and plating wastes from another industry are discharged to Harvester Ditch. One large industry in northern Fort Wayne, located on a tributary of the St. Joseph River, discharges soluble oils and plating wastes to a lagoon.

Auburn Area

A gas manufacturing plant located on a tributary ditch to Cedar Creek which empties into the St. Joseph River has, at times, discharged wastes high in phenol content. The City of Fort Wayne, with its water works intake located approximately 23 miles below the point of discharge of these wastes, has frequently reported phenol difficulties.

Table 10 of the appendix lists the industries discharging wastes having effects other than deoxygenation grouped according to type of waste. The list includes 16 such industries in Ohio and 5 in Indiana, a total of 21 in the basin.

It is noted that the industries listed may have wastes other than those by which they are classified. However, these other wastes are insignificant in comparison to the principal wastes produced.

Fourteen of the industries listed in table 10 are included also in table 9 as contributing deoxygenating wastes.

POLLUTION ABATEMENT REQUIREMENTS

The 1950 - 1951 pollution survey of the Maumee River drainage basin provides data on the location, types, magnitude, and effects of pollution. Together with other information, such as hydrological data, water uses, and water quality requirements, the survey data form the basis for determining pollution abatement requirements to meet the objectives defined in a previous section of this report.

The survey data show that the dissolved oxygen content fell below the desirable objective of four ppm at many places under flow conditions experienced during the survey. At critical stream flows (Ref. Section II, Hydrological Data), which would be lower in all instances than those occurring during the survey, oxygen depletion would be even more serious. The data show, further, that oils, metals, acids, phenols, and other chemical substances were discharged in quantities which resulted in undesirable concentrations in the streams. Bacteriological data indicate excessive pollution in the lower Maumee River and at certain public water supply intakes located on the Maumee River.

Pollution abatement requirements indicated herein are based on existing pollution loads and are directed toward the protection of desirable water uses, especially uses for public water supplies. Additional requirements will be established should increased pollution loads endanger those water uses essential to the public interests. Abatement works necessary to preserve these uses should provide for reasonable population and industrial growth.

A previous section of this report discusses the methods for a mathematical analysis of biochemical oxygen demand (B. O. D.) reduction requirements. In general, as indicated in the section on Hydrological Data, critical stream flows on tributary streams are so low in relation to the pollution load that, in most instances, the requirement of a high degree of treatment is apparent without a detailed mathematical analysis.

Main Stem of Maumee River

Fort Wayne Area (Including sources discharging wastes to small tributary streams or drainage ditches in the area.)

Wastes from municipal sewers at Fort Wayne and New Haven are given secondary treatment before discharge to the Maumee River. One industry

producing organic wastes provides equivalent treatment. Other industries in the area which discharge organic wastes direct to the streams should provide additions, new treatment works, or other methods of pollution control to obtain a reduction in B.O.D. comparable to that obtained by the municipalities. Oil, brine, and plating wastes originating in the area should be controlled to meet water quality objectives.

Toledo Area

Complete treatment (not less than 85 percent reduction of B.O.D.), including disinfection, has been established as the requirement for Toledo. In fixing this requirement the prime considerations were protection of the Toledo water supply, the intake for which is located in Lake Erie beyond the mouth of the Maumee River, and protection of bathing beaches along the shores of Lake Erie. The city of Toledo is actively progressing in a program to expand the municipal sewage treatment works to meet or better the requirement. Some of the industries in the Toledo area have partial treatment but none are adequate. Treatment to reduce the B.O.D. of industrial organic wastes comparable to that required for municipal sewage at Toledo should be provided. Control of oil, plating, phenolic, color producing, and other wastes to meet water quality objectives is essential.

Maumee River Between Toledo and Fort Wayne

No wastes of consequence are discharged directly to the Maumee River in Indiana except in the Fort Wayne area.

A detailed analysis was made of the reduction in pollution load necessary to maintain desirable water quality in the Maumee River downstream from Defiance, Ohio. A critical point occurs between Defiance and Napoleon under present conditions of pollution loading. The analysis, based on observed conditions in the River, was affected by many factors such as variations in applied loads, variations in flows, effects of previously deposited sludge, and other factors. However, the data definitely indicated that more than primary treatment is needed but that less than complete treatment should be satisfactory. A theoretical analysis, using assumed stream self-purification constants, supported conclusions based on field data.

Based on 1950 - 1951 loads treatment sufficient to reduce the B.O.D. contributed in municipal and industrial wastes by not less than 65 percent should provide reasonable protection for the Maumee River. Accordingly this degree of treatment is established as the present requirement for sources of pollution on the Maumee River in Ohio above Toledo.

Provisions should be made to facilitate addition of a higher degree of treatment in the future.

In addition to B.O.D. reduction, disinfection of sewage treatment plant effluent is required at Defiance and Napoleon to protect downstream public water supplies. Provision should be made for the addition of disinfection facilities at other municipal sewage treatment plants in the event this becomes necessary for protection of public water supplies.

St. Joseph River

Indiana

Garrett, Waterloo, and Butler, all in Indiana and located on small tributaries, need to provide secondary treatment (85 to 95 percent reduction of B.O.D.). Auburn, Indiana, provides secondary treatment but does not treat all sewage discharged to the stream. Adequate collection of sewage is needed. Avilla and Grabill, Indiana, have no comprehensive system of sewers at this time.

Further reduction of phenols from a plant at Auburn is required. Control of wastes from a cannery at Grabill is required.

Ohio

An initial installation of primary treatment, but with planning for future plant expansion, at Pioneer, Montpelier, and Edgerton should provide reasonable protection of water quality at this time. The drainage area above Pioneer is only about 28 square miles but the drainage area is more than doubled a short distance below the outfall. Satisfactory water quality below Edgerton is largely dependent on adequate control of cannery wastes. In comparison to this industrial waste, the load from Edgerton is quite small and the difference between primary and secondary treatment would have no significant effect on the stream.

Edon, Ohio, has no comprehensive public sewer system at this time. A high degree of treatment will be required when sewers are installed.

Waste loads from canneries should be reduced or controlled to the maximum extent practical of attainment.

St. Marys River

Indiana

Baer Field has adequate treatment. Secondary treatment (85 to 95 percent reduction of B.O.D.) is required at Decatur and Berne.

Of the two industries contributing wastes, one provides adequate treatment and the other plans connection to Decatur sewers if wastes are found to be treatable in a municipal plant.

Ohio

The load-stream flow relations in the upper St. Marys River in Ohio are such that a high degree of treatment is required for all municipal and industrial wastes. At present St. Marys and New Bremens provide secondary treatment. One industry provides adequate treatment. Other industries provide little or no treatment.

Tiffin River

Ohio

One meat packing company, tributary to the Tiffin River in the Defiance area, should provide control commensurate with requirements for Defiance.

Primary treatment at Stryker, but with planning for plant expansion, should be adequate for the present.

A high degree of treatment or control is required for organic wastes from all other municipal and industrial sources of pollution now discharged into the Tiffin River or its tributaries. In the Archbold area, the highest degree of treatment practical of attainment is needed to prevent nuisance conditions in the small receiving stream.

Bryan provides adequate treatment. One industry provides substantial treatment and two others provide some. However, all industries require either new facilities or improvements to existing ones.

Auglaize River

Indiana

Secondary treatment should be provided at Monroeville.

Ohio

The highest degree of treatment practical of attainment should be provided for municipal wastes and for industries in or near Delphos, Ottawa, Findlay, and Lima. Findlay and Lima have secondary treatment but both need enlargement. Need for a high degree of treatment is indicated at Bluffton, Dunkirk, Arlington, Forest, and Ada. Intermediate treatment at Paulding and Rawson and Primary treatment at Pandora and Payne should prove adequate at this time. Kalida has no comprehensive system of sewers. If completely sewered, primary treatment should be adequate at present. In each case initial planning should make provision for plant expansion.

Industries discharging oil wastes in the Lima and Findlay area, those discharging plating wastes at Spencerville, Delphos, and Bluffton, and the industry discharging phenolic wastes in the Lima area should provide abatement or control works adequate to meet the water quality objectives.

Convoy and Columbus Grove have secondary treatment which is adequate.

Of 24 industries discharging wastes in the Auglaize River basin, 15 have some form of treatment. Three of these provide satisfactory treatment or control of wastes and another one requires only minor improvements.

Minor Tributaries to the
Main Stem of the Maumee River
(except Ft. Wayne Area)

Ohio

All municipalities and industries at focal points of pollution on minor tributaries of the Main Stem of the Maumee River are located on streams having low critical flows in relation to the pollution load. A high degree of treatment or other control of municipal and industrial wastes is required to maintain desirable water quality objectives.

Hicksville provides complete treatment but needs enlargement. One cannery provides adequate control of wastes and another, though requiring improvements, is substantially adequate. Six industries require additions or new facilities.

APPENDIX

DRAINAGE AREA

OHIO	4856 SQ. MI.
INDIANA	1260 SQ. MI.
MICHIGAN	470 SQ. MI.
TOTAL IN BASIN	6586 SQ. MI.

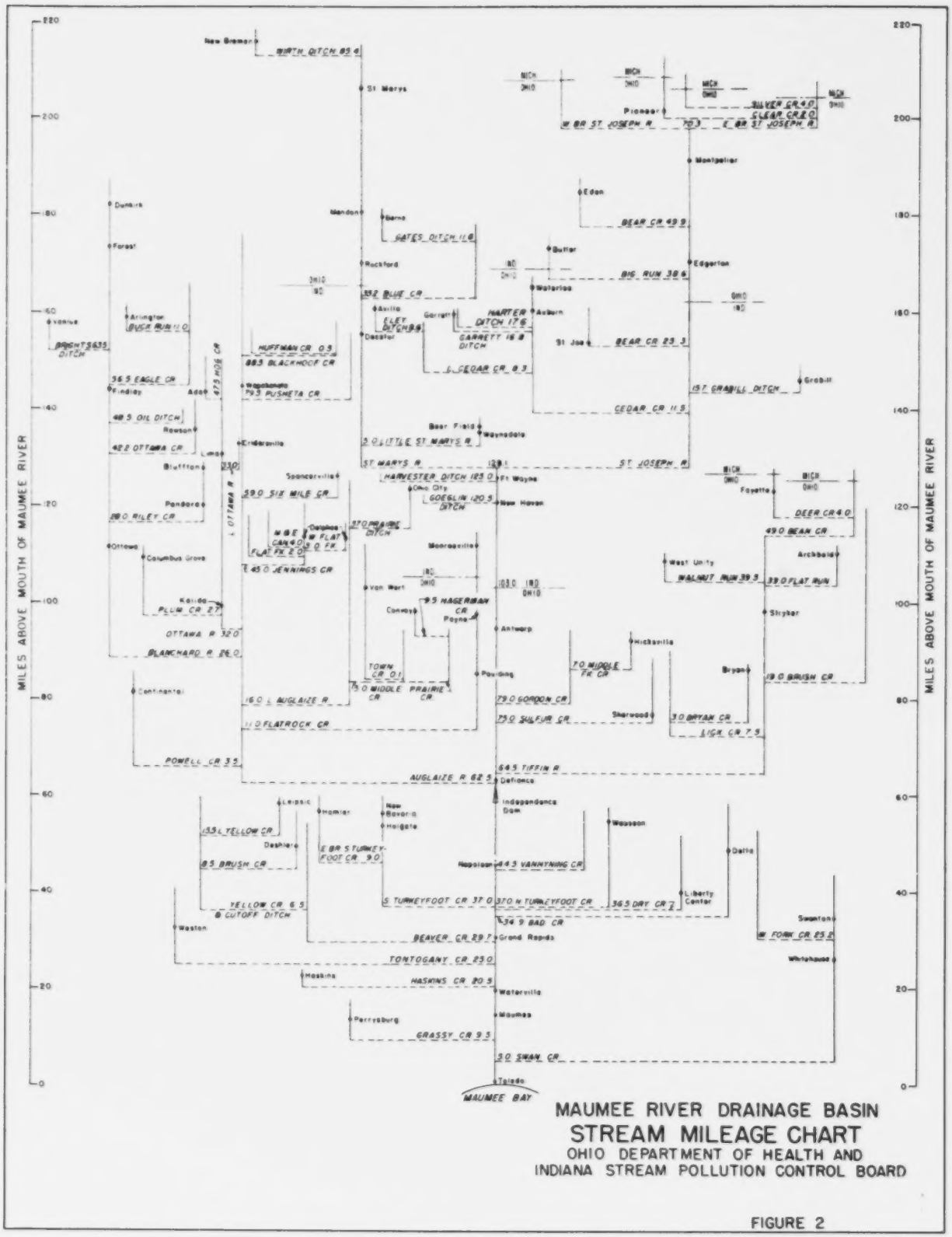
LOCATION PLAN
MAUMEE RIVER DRAINAGE BASIN

MAUMEE RIVER DRAINAGE BASIN
GENERAL REFERENCE MAP

OHIO DEPARTMENT OF HEALTH
AND
INDIANA STREAM POLLUTION CONTROL BOARD
1952

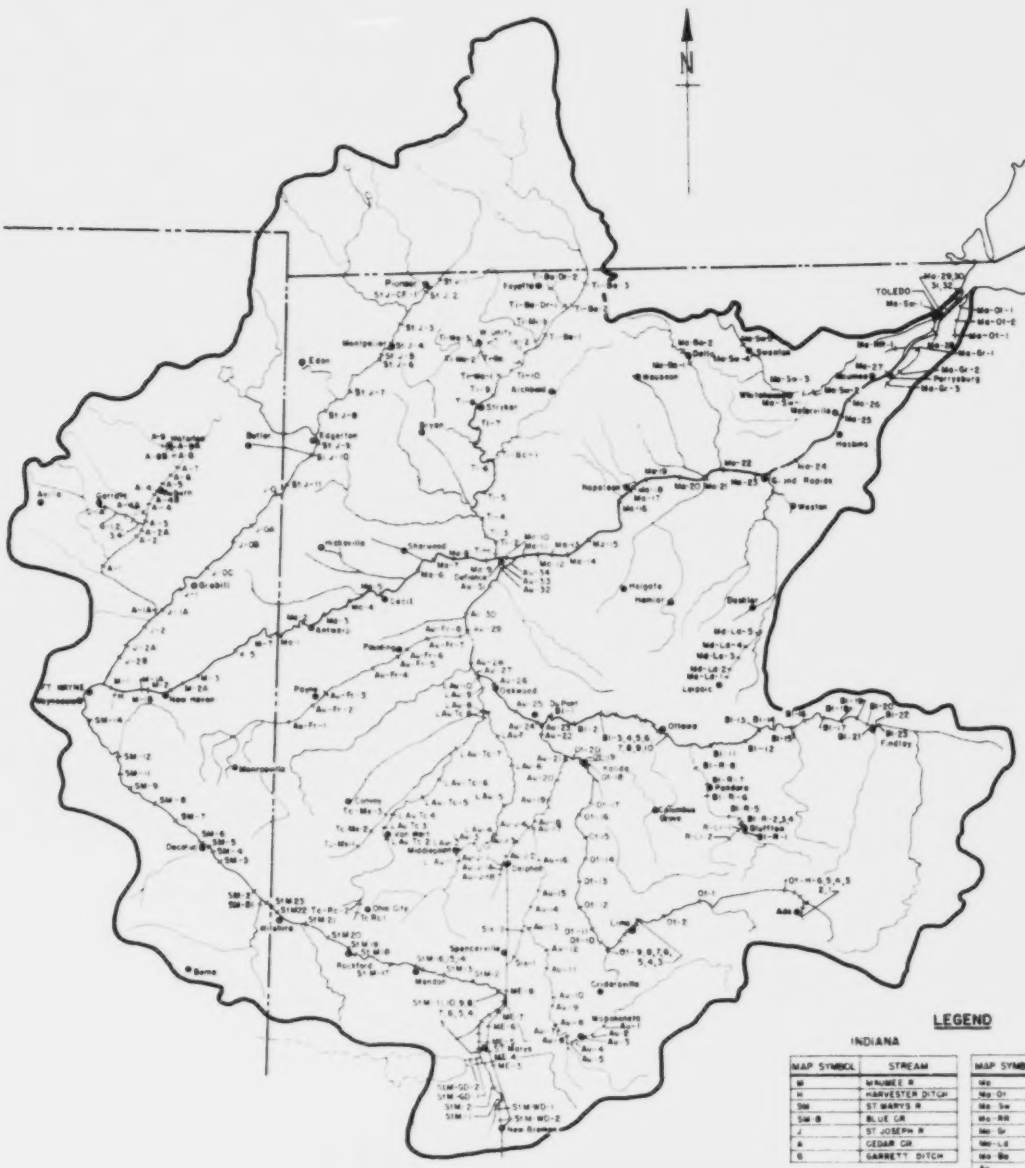
0 10 20
STATUTE MILES

FIGURE 1



MAUMEE RIVER DRAINAGE BASIN
STREAM MILEAGE CHART
OHIO DEPARTMENT OF HEALTH AND
INDIANA STREAM POLLUTION CONTROL BOARD

FIGURE 2



LEGEND

INDIANA

MAP SYMBOL	STREAM
M	MAUMEE R
H	HARVESTER DITCH
SM	ST MARYS R
SM-B	BLUE CR
J	ST JOSEPH R
A	CEDAR CR
G	GARRETT DITCH

OHIO

MAP SYMBOL	STREAM
Ma	MAUMEE R
Ma-Ot	OTTER CR
Ma-Sw	SWAN CR
Ma-RR	RUHR ROAD CR
Ma-Gr	GRASSY CR
Ma-Le	LEIPSIC DITCH
Ma-Ba	BAD CR
Au	AUGLAIZE R
Au-Fr	FLATROCK CR
L-Au	LITTLE AUGLAIZE R
L-Au-Tc	TOWN CR
Tc-Ma	MADDOX CR
Tc-Ro	ROLLER CR
Bl	BLANCHARD R
Bl-R	RILEY CR
R-Lr	LITTLE RILEY CR
Ot	OTTAWA R
Ot-H	HOG CR
Au-J	JENNINGS CR
ME	MIAMI-ERIE CANAL
Six	SIX MILE CR
T	TIFFIN R
T-Be	BEAN CR
T-Be-Dr	DEER CR
T-Br	BRUSH CR
T-Wa	WALNUT RUN
T-Mi	MILL CR
T-Ba	BATES CR
St M	ST MARYS R
St M-WD	WORTH DITCH
St M-GD	GOODYEAR DITCH
St J	ST JOSEPH R
St J-CF	CLEAR FORK

LOCATION PLAN
MAUMEE RIVER DRAINAGE BASIN

MAUMEE RIVER DRAINAGE BASIN
LOCATION OF SAMPLING STATIONS

1950-51 SURVEY
OHIO DEPARTMENT OF HEALTH
AND
INDIANA STREAM POLLUTION CONTROL BOARD

10 0 10 20
SCALE IN MILES

FIGURE 3

MAUMEE RIVER BASIN

TABLE 1. - POPULATION TRENDS, 1900 - 1950

Year	Population* of Maumee River Basin						
	Indiana	Michigan	Ohio	Total	Unincorporated Places	Incorporated Places	% of Total in Incorporated Places
1900	119,482	23,982	479,002	622,466	276,726	345,740	55.5
1910	134,909	23,234	507,632	665,775	248,821	416,954	62.6
1920	168,567	22,131	584,834	775,532	243,727	531,805	68.6
1930	186,183	21,434	633,409	841,026	225,656	615,370	73.2
1940	194,530	22,550	638,266	855,346	229,386	625,960	73.2
1950	223,396	26,532	698,632	948,560	258,725	689,835	72.7

* Based on data from decennial reports of the Bureau of the Census

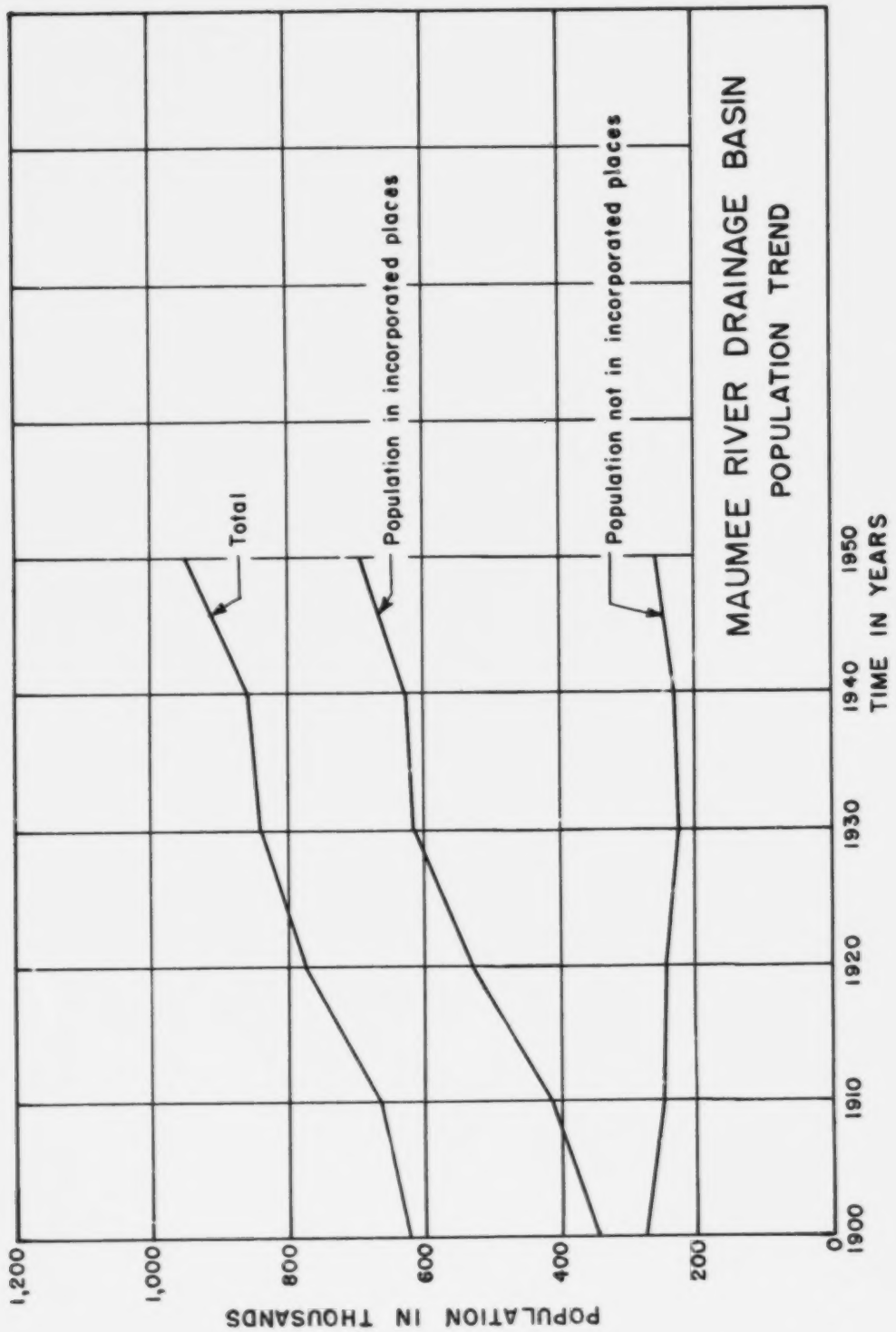

MAUMEE RIVER DRAINAGE BASIN
POPULATION TREND
Total
Population in incorporated places
Population not in incorporated places
POPULATION IN THOUSANDS
1,200
1,000
800
600
400
200
0
1900
1910
1920
1930
1940
1950
TIME IN YEARS

FIGURE 4

MAUMEE RIVER BASIN

TABLE 2. - DISTRIBUTION BY SUBWATERSHED AREAS OF POPULATION IN COMMUNITY POLLUTION SOURCES

Subwatershed	Drainage Area Sq. Miles	Per Cent of Total Area	1950 Population of Communities listed as Sources of Pollution	Number of Cities over 5000
St. Joseph	1,060	16.1	21,470	1
St. Marys	817	12.4	21,846	2
Blanchard	762	11.6	33,257	1
Ottawa	373	5.7	57,039	1
Auglaize*	1,313	19.9	31,565	3
Tiffin	804	12.2	9,880	1
Maumee** (above Defiance)	381	5.8	140,304	1
Maumee*** (Defiance & below)	1,076	16.3	346,915	4
Total	6,586	100.0	662,276	14

* The Blanchard and Ottawa Rivers are tributaries of the Auglaize. The area and community population listed for the Auglaize do not include those of the Blanchard and Ottawa River Drainage Basins.

** Includes Ft. Wayne.

*** Includes all of Toledo.

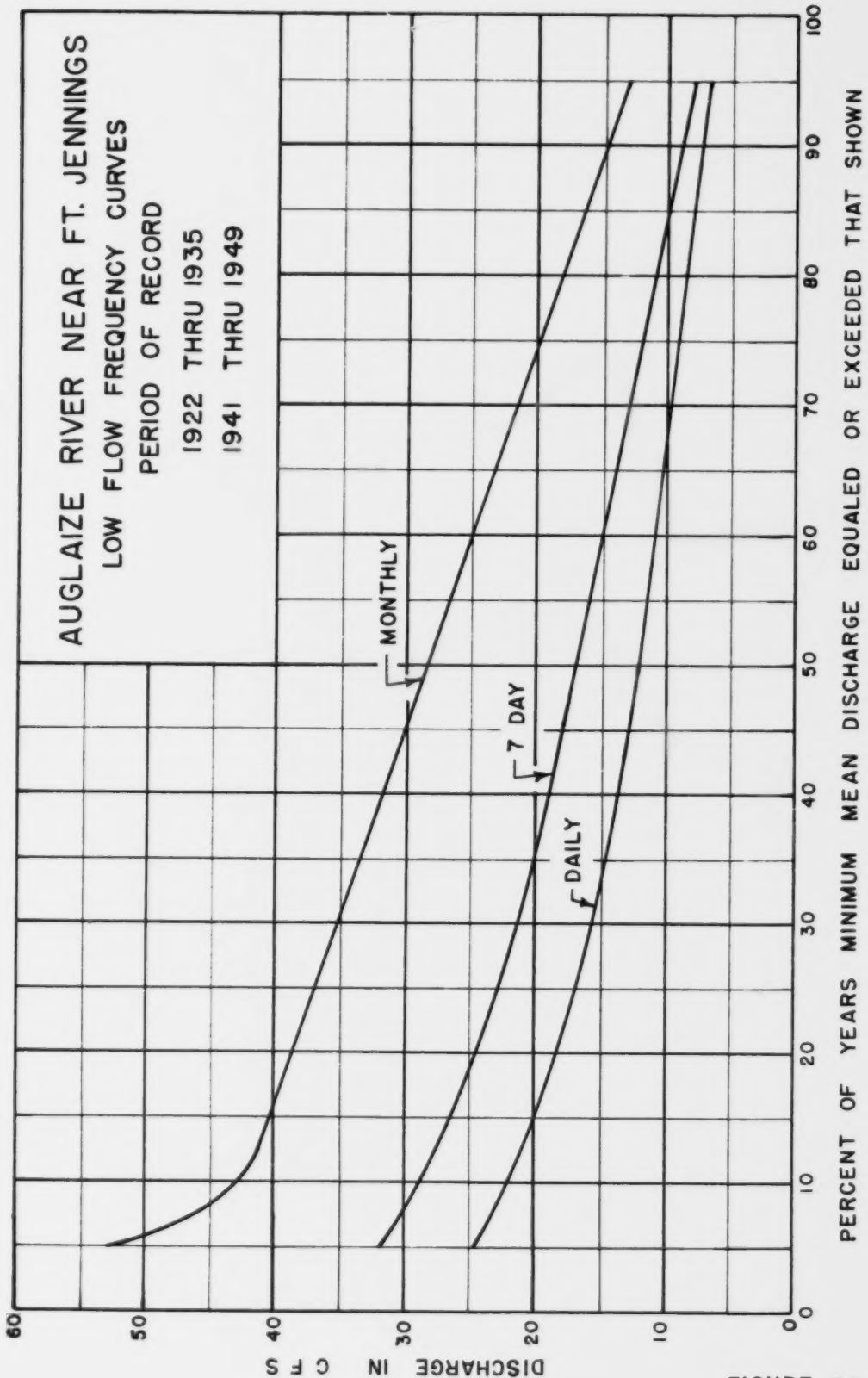

AUGLAIZE RIVER NEAR FT. JENNINGS
LOW FLOW FREQUENCY CURVES
PERIOD OF RECORD
1922 THRU 1935
1941 THRU 1949
MONTHLY
7 DAY
DAILY
DISCHARGE IN C F S
0
10
20
30
40
50
60
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF YEARS MINIMUM MEAN DISCHARGE EQUALED OR EXCEEDED THAT SHOWN

FIGURE 5A

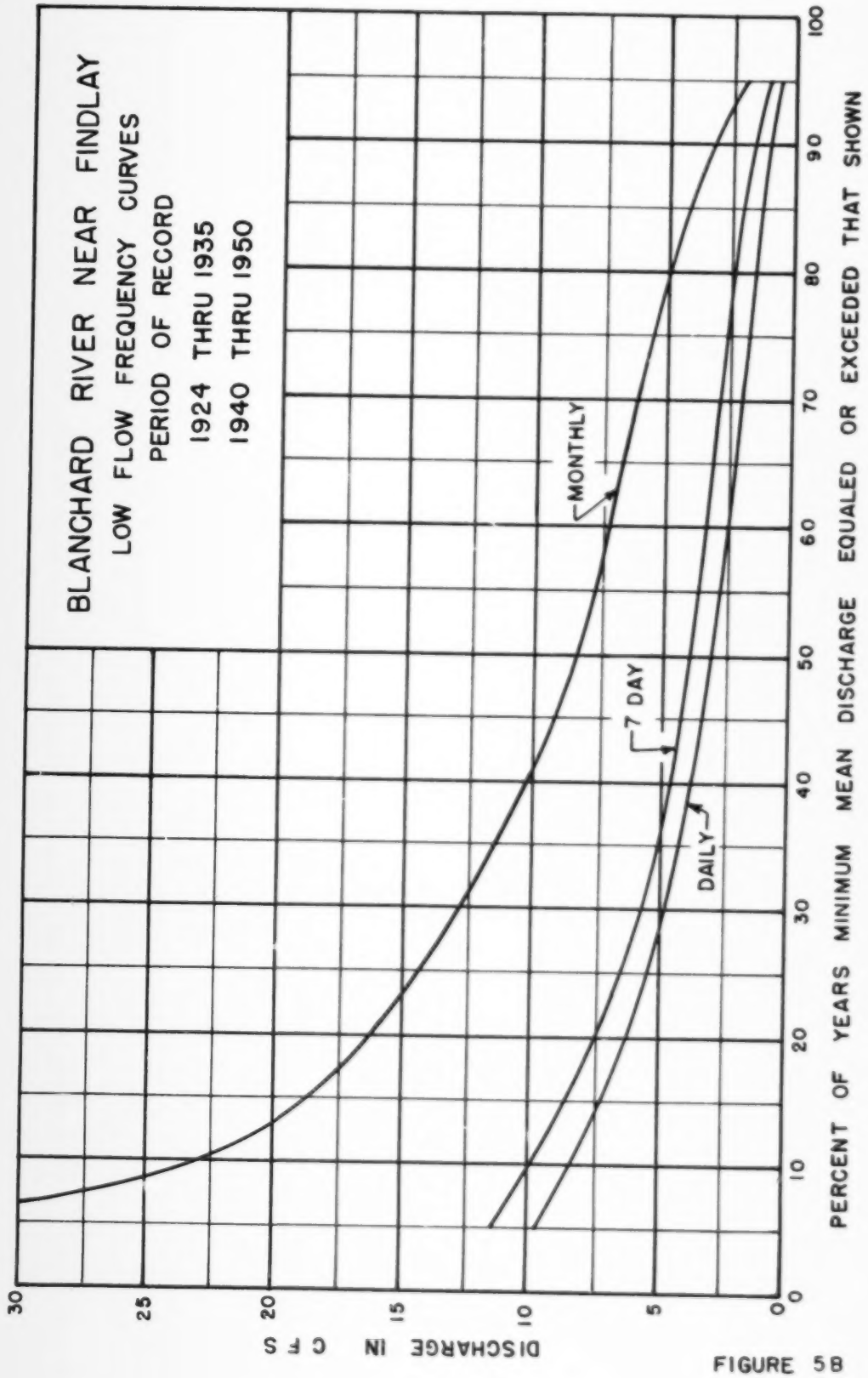

BLANCHARD RIVER NEAR FINDLAY
LOW FLOW FREQUENCY CURVES
PERIOD OF RECORD
1924 THRU 1935
1940 THRU 1950
MONTHLY
7 DAY
DAILY
DISCHARGE IN C F S
0
5
10
15
20
25
30
PERCENT OF YEARS MINIMUM MEAN DISCHARGE EQUALED OR EXCEEDED THAT SHOWN
0
10
20
30
40
50
60
70
80
90
100

FIGURE 58

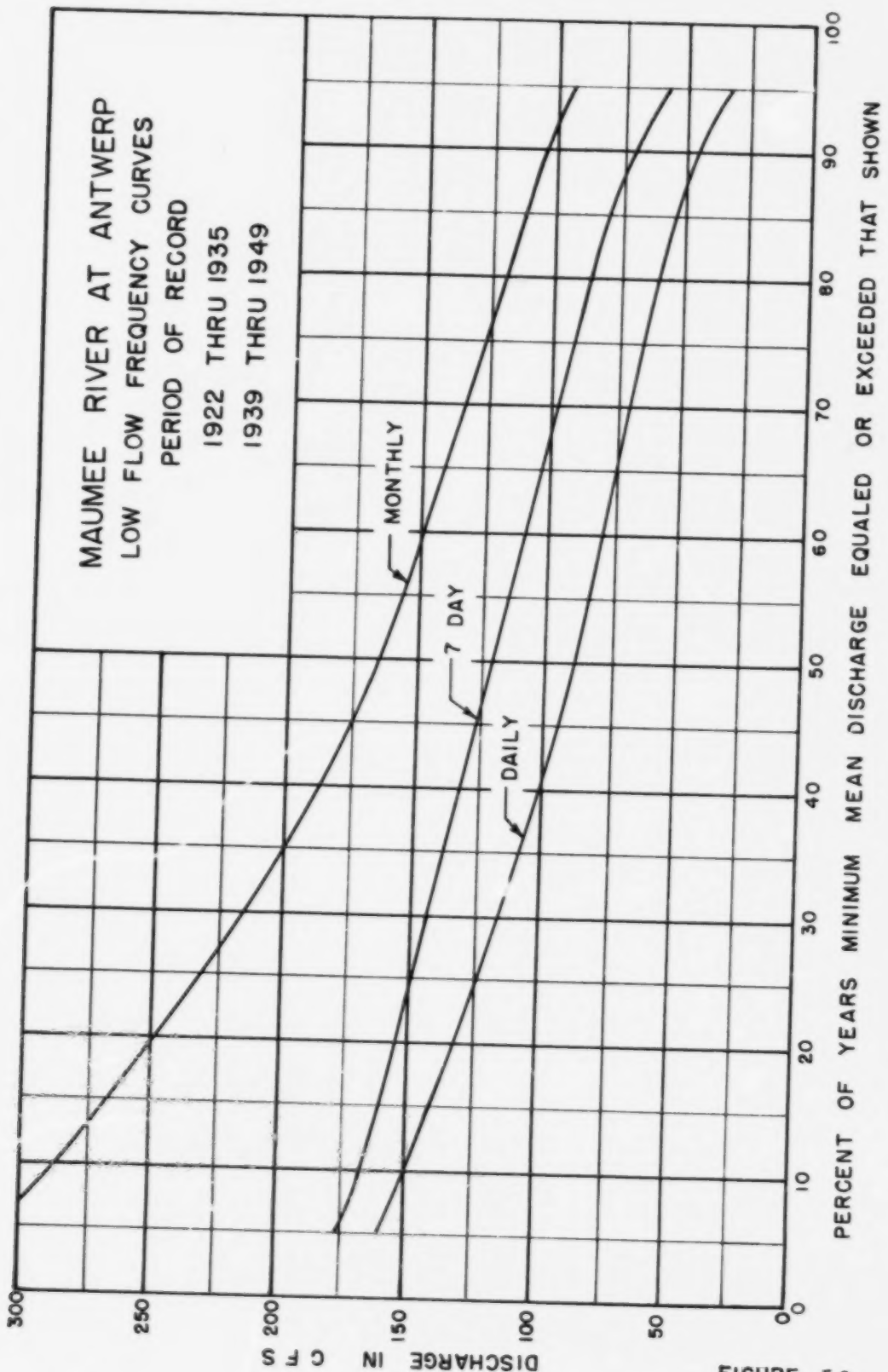

MAUMEE RIVER AT ANTWERP
LOW FLOW FREQUENCY CURVES
PERIOD OF RECORD
1922 THRU 1935
1939 THRU 1949
MONTHLY
7 DAY
DAILY
DISCHARGE IN C F S
300
250
200
150
100
50
0
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF YEARS MINIMUM MEAN DISCHARGE EQUALED OR EXCEEDED THAT SHOWN

FIGURE 5C

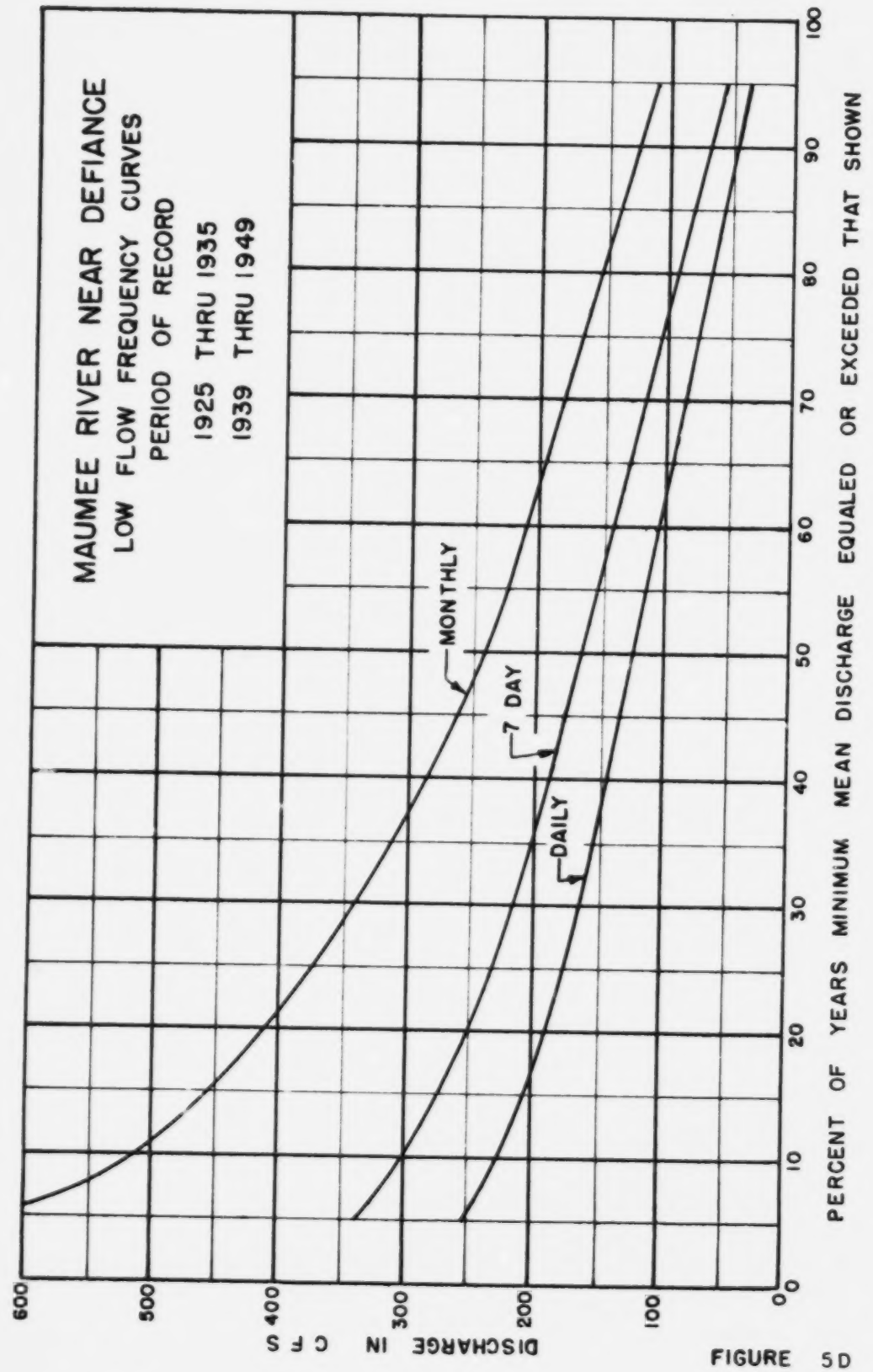

MAUMEE RIVER NEAR DEFIANCE
LOW FLOW FREQUENCY CURVES
PERIOD OF RECORD
1925 THRU 1935
1939 THRU 1949
MONTHLY
7 DAY
DAILY
DISCHARGE IN C F S
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF YEARS MINIMUM MEAN DISCHARGE EQUALED OR EXCEEDED THAT SHOWN

FIGURE 5D

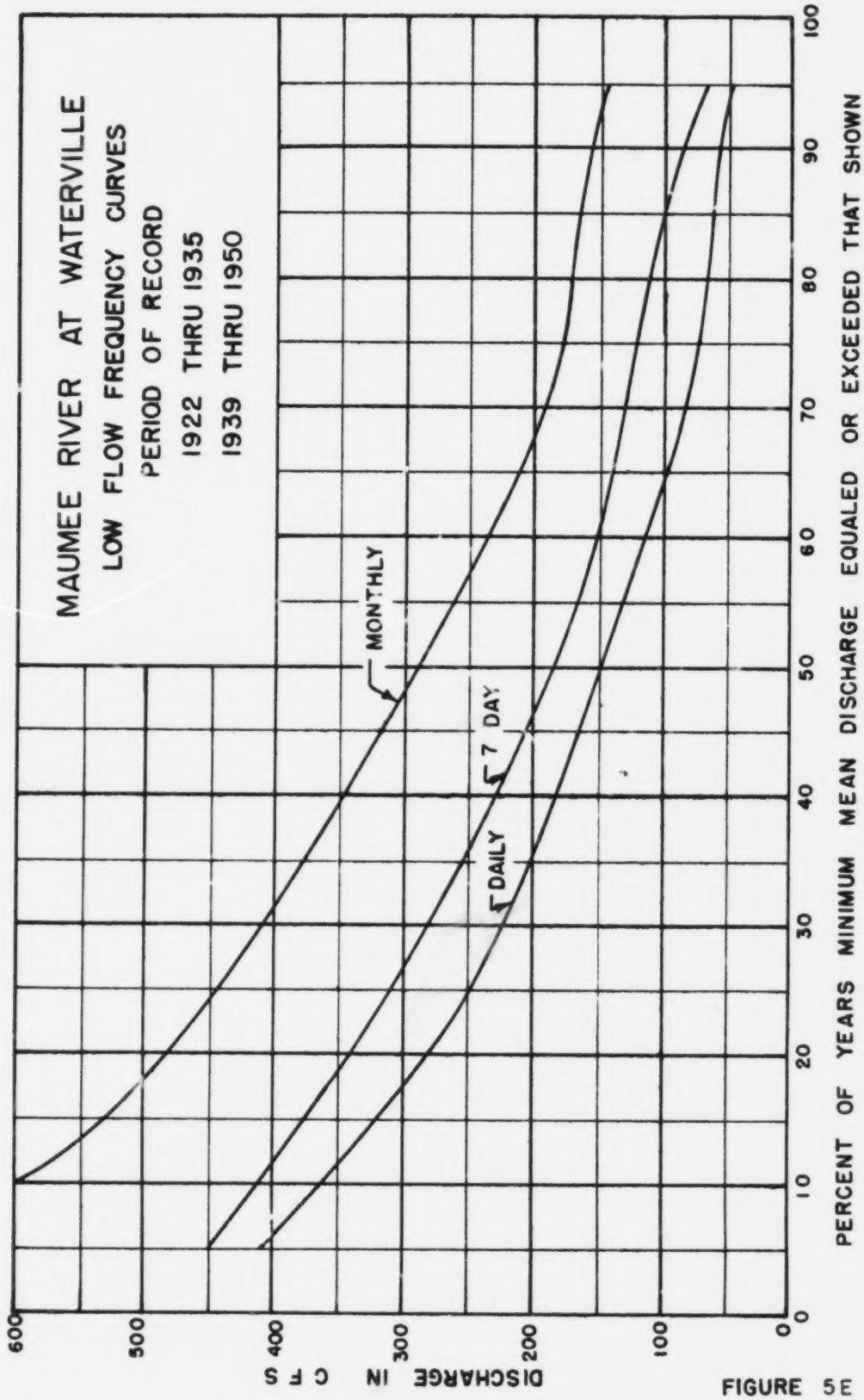

MAUMEE RIVER AT WATERVILLE
LOW FLOW FREQUENCY CURVES
PERIOD OF RECORD
1922 THRU 1935
1939 THRU 1950
MONTHLY
7 DAY
DAILY
DISCHARGE IN C F S
600
500
400
300
200
100
0
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF YEARS MINIMUM MEAN DISCHARGE EQUALED OR EXCEEDED THAT SHOWN

FIGURE 5E

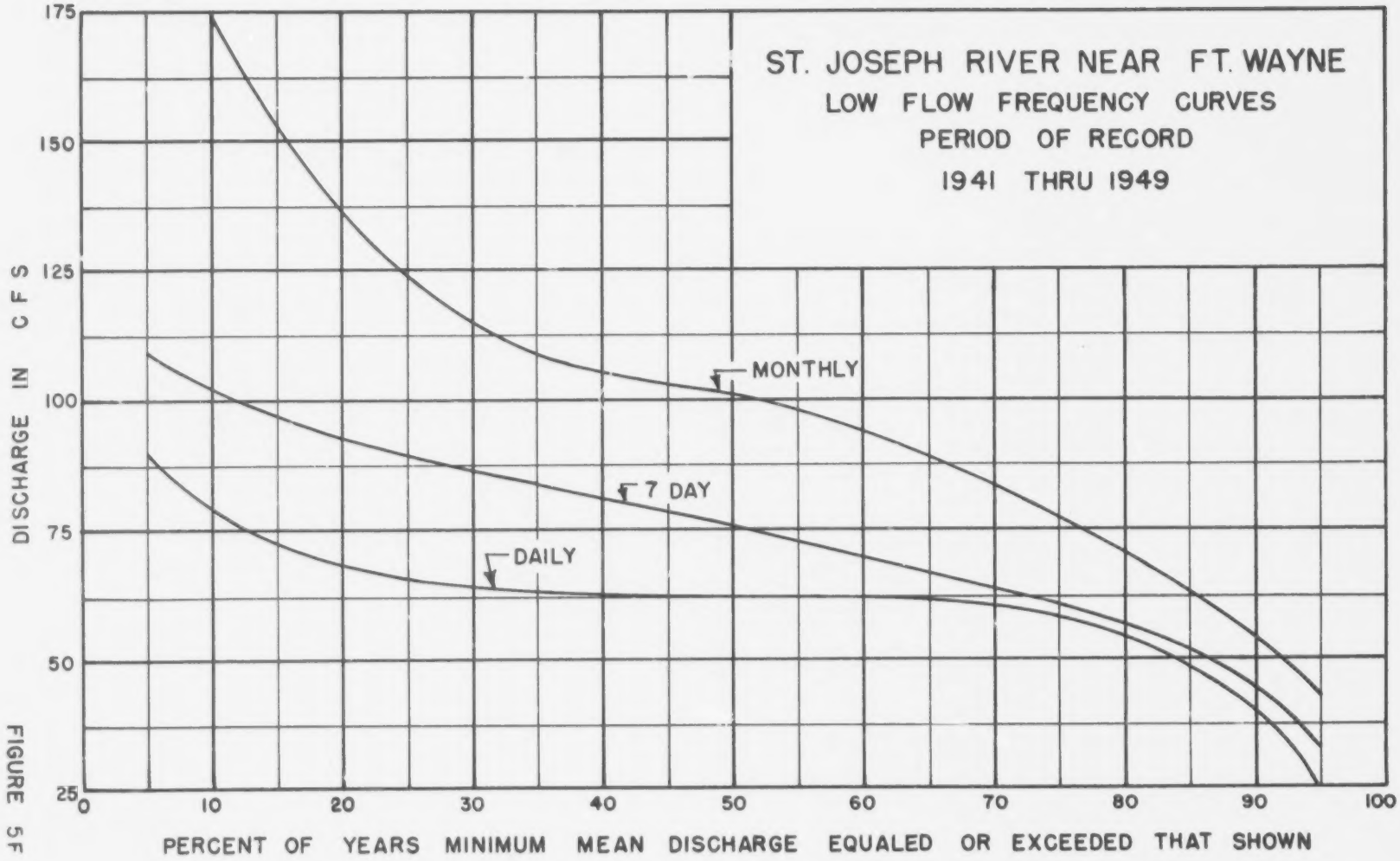

ST. JOSEPH RIVER NEAR FT. WAYNE
LOW FLOW FREQUENCY CURVES
PERIOD OF RECORD
1941 THRU 1949
MONTHLY
7 DAY
DAILY
DISCHARGE IN C F S
175
150
125
100
75
50
25
0
10
20
30
40
50
60
70
80
90
100
PERCENT OF YEARS MINIMUM MEAN DISCHARGE EQUALED OR EXCEEDED THAT SHOWN

FIGURE 5F

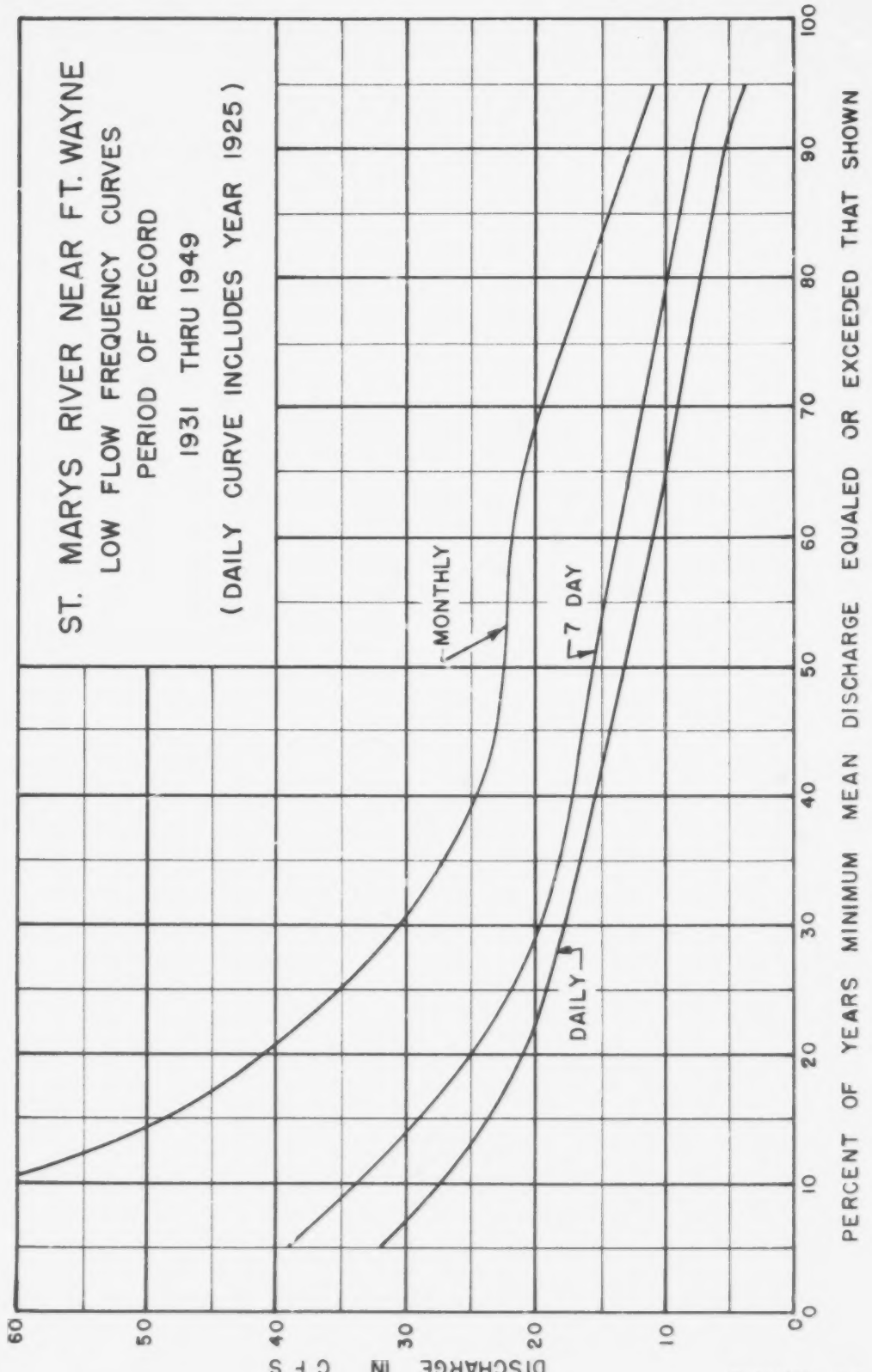

ST. MARYS RIVER NEAR FT. WAYNE
LOW FLOW FREQUENCY CURVES
PERIOD OF RECORD
1931 THRU 1949
(DAILY CURVE INCLUDES YEAR 1925)
MONTHLY
7 DAY
DAILY
DISCHARGE IN C F S
0
10
20
30
40
50
60
PERCENT OF YEARS MINIMUM MEAN DISCHARGE EQUALED OR EXCEEDED THAT SHOWN
0
10
20
30
40
50
60
70
80
90
100

FIGURE 5G

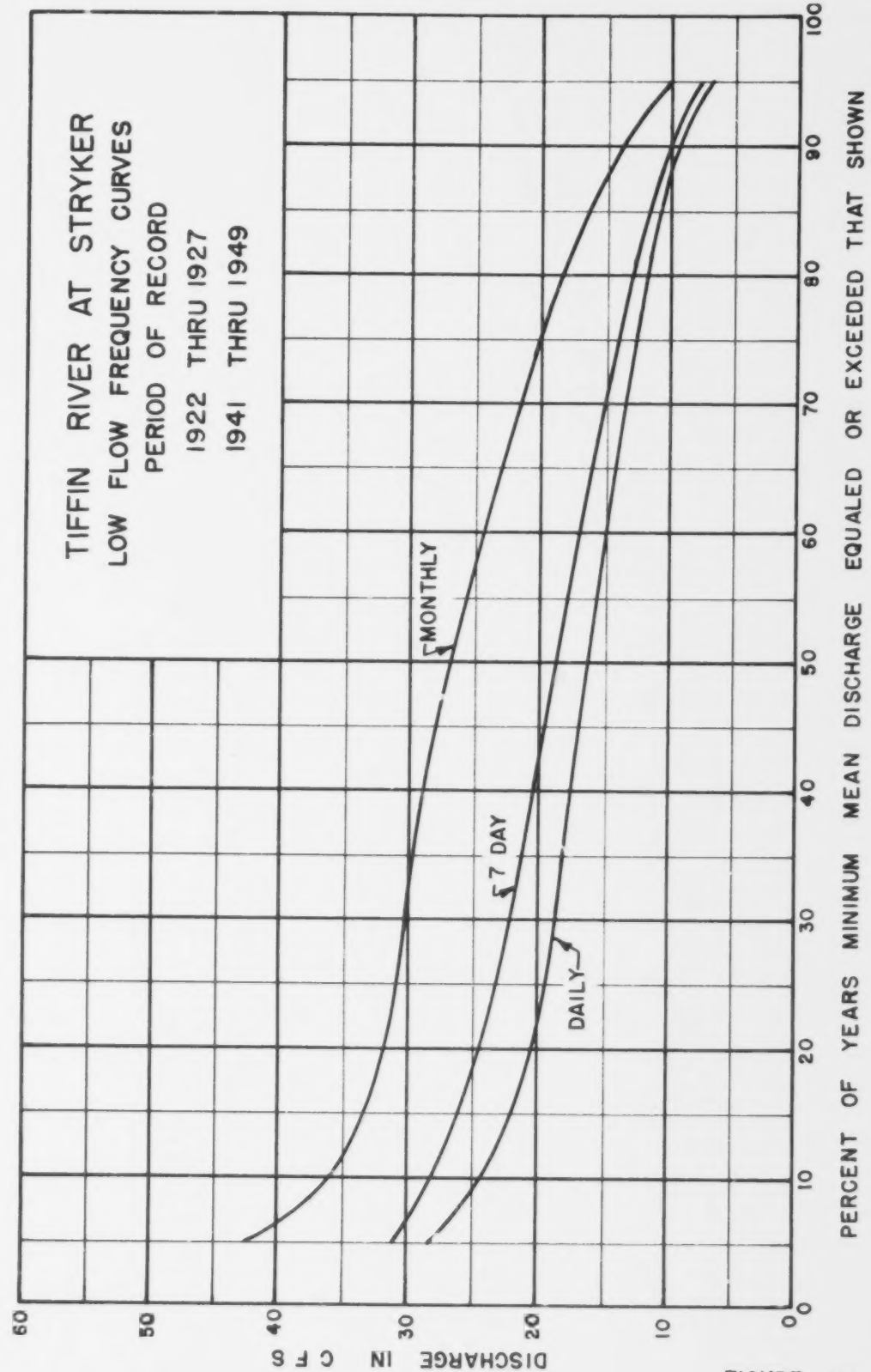

TIFFIN RIVER AT STRYKER
LOW FLOW FREQUENCY CURVES
PERIOD OF RECORD
1922 THRU 1927
1941 THRU 1949
MONTHLY
7 DAY
DAILY
DISCHARGE IN C F S
PERCENT OF YEARS MINIMUM MEAN DISCHARGE EQUALED OR EXCEEDED THAT SHOWN
0
10
20
30
40
50
60
70
80
90
100

FIGURE 5H

MAUMEE RIVER BASIN

TABLE 3. - CRITICAL FLOWS AT GAGING POINTS ON MAUMEE RIVER AND TRIBUTARIES

Stream	Location	Critical Flow (c.f.s.) (1)	Drainage Area (Sq. Mi.)	Yield Per Sq. Mi. (c.f.s.)
Auglaize	Ft. Jennings, Ohio	11	333	0.0330
Blanchard	Findlay, Ohio	2.5	343	0.0073
Maumee	Antwerp, Ohio	87	2,049	0.0425
Maumee	Defiance, Ohio	90	5,530	0.0163
Maumee	Waterville, Ohio	112	6,314	0.0177
St. Joseph	Ft. Wayne, Indiana	57	1,060	0.0538
St. Marys	Ft. Wayne, Indiana	10	753	0.0133
Tiffin	Stryker, Ohio	13	444	0.0293

(1) Minimum seven-consecutive-day average flow which probably will be equaled or exceeded in 80 percent of the years.

MAUMEE RIVER BASIN

TABLE 4. - SUMMARY OF PUBLIC WATER SUPPLY INFORMATION

Community	Source of Supply	Treatment	Population 1950 Census	Ave. Daily Consumption M. G. D.
Indiana				
Auburn	Wells	Disinfection	5, 879	0. 660
Avilla	Wells	None	669	0. 040
Berne	Wells	None	2, 277	0. 148
Butler	Wells	None	1, 914	0. 133
Decatur	Wells	Nos. 1 & 2 } Standby Nos. 4, 5 & 6} Nos. 7, 8 & 9 - Iron removal, zeolite softening, and disinfection	7, 271	
Fort Wayne	St. Joseph River	Lime-soda softening, fluoridation, and disinfection	133, 607	18. 5
Garrett	Wells	Disinfection (partial)	4, 291	0. 490
Monroeville	Wells	Disinfection	1, 150	0. 050
New Haven	Wells	Zeolite softening and disinfection	2, 336	0. 19
St. Joe	Well	Disinfection	479	0. 018
Waterloo	Wells	None	1, 414	0. 159
Waynedale	Wells	Zeolite softening and disinfection	2, 500*	0. 100
Michigan				
Hudson	Wells	None	2, 773	
Morenci	Wells	Disinfection	1, 983	
Reading	Well	None	1, 125	
Ohio				
Ada	Wells	Lime-soda softening	3, 640	0. 170
Alger	Well	Iron removal	943	. 030
Antwerp	Wells	None	1, 162	0. 030
Archbold	Up-ground reservoir. Supplied from Brush Cr.	Lime-soda softening and disinfection	1, 486	0. 085
Arlington	Wells	Aeration for H_2S reduction and zeolite softening	825	0. 025
Bluffton	Wells	Aeration for H_2S reduction and disinfection	2, 423	0. 180
**Bowling Green	Maumee River	Lime-soda softening and disinfection	12, 005	1. 1
Bryan	Wells	None	6, 365	0. 450
Columbus Grove	Wells	None	1, 936	0. 135
Continental	Wells	None	1, 023	
Convoy	Wells	None	910	0. 021
Defiance	Maumee River	Lime-soda softening, pre-chlorination, and disinfection	11, 265	2. 1
Delphos	Well	Disinfection	6, 220	0. 360
Delta	Up-ground storage reservoir supplied from Bad Cr.	Purification and disinfection	2, 120	0. 127
Deshler	Wells	Iron removal, zeolite softening, and disinfection	1, 623	0. 075
Dunkirk	Wells	Aeration for H_2S reduction and zeolite softening	972	0. 018
Edgerton	Well	Zeolite softening	1, 246	0. 06
Edon	Wells	None	645	0. 024
Elida	Wells	Aeration for H_2S reduction	607	

* 1950 estimate (unincorporated).

** Sewage drains into Portage River outside Maumee Basin.

MAUMEE RIVER BASIN

TABLE 4. - SUMMARY OF PUBLIC WATER SUPPLY INFORMATION - Continued.

Community	Source of Supply	Treatment	Population 1950 Census	Ave. Daily Consumption M.G.D.
Ohio				
Fayette	Wells	None	1,003	0.035
Findlay	Up-ground storage reservoir, supplied from Blanchard R., and wells	Lime-soda softening	23,845	2.67
Forest	Wells	Lime-soda softening	1,114	0.04
Grand Rapids	Well	Disinfection	657	0.02
Hamler	Well	Iron removal	490	0.07
Hicksville	Wells	None	2,629	0.09
Holgate	Wells	Disinfection	1,092	0.075
Kalida	Well	Iron removal and H_2S reduction	533	
Leipsic	Wells	Lime-soda softening	1,706	0.17
Liberty Center	Well	Aeration for H_2S reduction	816	0.018
Lima	3 Up-ground storage reservoirs supplied from Ottawa River	Lima-soda softening, and disinfection	50,246	8.0
Lucas County Sewer District Dist. #10 and 1/6th Dist. #11 in Maumee watershed.	Toledo		15,400*	
Maumee	Toledo	See Toledo	5,548	
Mendon	Well	Iron removal	614	
Middlepoint	Well	None	583	0.07
Montpelier	Wells	Lime-soda softening and disinfection	3,867	0.38
Mount Blanchard	Well	None	444	0.032
Napoleon	Maumee River	Purification and disinfection	5,335	0.686
New Bremen	Wells	Zeolite softening, iron removal, and disinfection	1,546	0.15
Oakwood	Wells	Aeration for H_2S reduction	542	0.001
Ohio City	Wells	None	861	0.045
Ottawa	Wells	Disinfection	2,962	0.13
Pandora	Well	Aeration for H_2S reduction and disinfection	717	
Paulding	Wells	Disinfection	2,352	0.250
Payne	Wells	None	1,062	0.045
Perrysburg	Wells	Disinfection	4,006	0.330
Pettisville	Well	None	300*	0.010
Pioneer	Wells	None	696	0.099
Rawson	Wells	None	407	0.025
Rockford	Wells	None	1,112	0.045
Rossford	Toledo	See Toledo	3,963	
St. Marys	Wells	Lime-soda softening	6,208	0.60
Sherwood	Well	None	570	0.029
Spencerville	Well	Disinfection	1,826	0.045
Stryker	Well	None	1,026	0.029

* Estimate

MAUMEE RIVER BASIN

TABLE 4. - SUMMARY OF PUBLIC WATER SUPPLY INFORMATION - Continued.

Community	Source of Supply	Treatment	Population 1950 Census	Ave. Daily Consumption M. G. D.
Ohio				
Swanton	Up-ground storage reservoir supplied from Swan Cr.	Lime-soda softening and disinfection	1,740	0.110
Toledo	• Lake Erie 2 miles off shore at Reno Beach	Purification and disinfection	303,616	59.0
Van Wert	Up-ground storage reservoir supplied from Town Cr.	Lime-soda softening and disinfection	10,364	0.57
Wapakoneta	Wells	Zeolite softening	5,797	1.0
Waterville	Maumee River	Purification and disinfection	1,110	0.09
Wauseon	2 up-ground storage reservoirs supplied from Big Ditch	Lime-soda softening and disinfection	3,494	0.35
Weston	Up-ground storage reservoir supplied from Jackson cut-off ditch	Purification and disinfection	973	0.039
West Unity	Well	None	827	0.015
Whitehouse	Well	None	849	0.02
Wood County Ross Twp.	Toledo	See Toledo	2,716	

• Note: Source outside Maumee drainage basin.

MAUMEE RIVER BASIN

TABLE 5. - DATA ON SOURCES OF POLLUTION

Municipalities with Populations Over 5,000

Municipality	Receiving Stream	Miles to Mouth of Maumee R.	Drainage Area, Sq. Mi.	1950 Census	Sewage Treatment	Population Equivalent Before Treatment	Population Equivalent Discharged to Rec'g Stream	Project Requirement	Remarks
Ohio									
Toledo	Maumee R.	0.6	6,586	303,616	Primary	458,800	331,200	Additions	
Maumee	Maumee R.	14.4	6,331	5,548	None	3,350 E	3,350 E	New Plant	One third of munic. sewage tributary to Toledo S.T.P. Plan under preparation.
Napoleon	Maumee R.	45.4	5,642	5,335	None	5,300 E	5,300 E	New Plant	Detailed plans approved.
Defiance	Maumee R.	63.2	5,510	11,265	None	33,800 E	33,800 E	New Plant	Includes wastes from Defiance Milk Products, Western Condensing, Gray & White Co., Swift & Co., Lutz Cannery. Detailed plans approved.
Wapakoneta	Auglaize R.	140.6	108	5,797	Secondary	13,600	500	None	
Van Wert	Town Cr.	102.9	34.9	10,364	Secondary	24,800	4,500 E	Enlargement	Includes wastes from St. Marys Packing Co., Borden's Cheese Co. Plans under preparation.
Findlay	Blanchard R.	139.5	363	23,845	Secondary	35,700	6,800	Enlargement	Detailed plans approved.
Lima	Ottawa R.	130.3	133	50,246	Secondary	92,000	10,300	Enlargement	Contracts awarded.
Delphos	Jennings Cr.	111.1	74.3	6,220	Primary	6,200	5,000	Additions	Plans under preparation.
Bryan	Bryan Cr.	86.5	10.2	6,365	Secondary	6,300	380	None	Includes wastes from Bryan Canning Co.
St. Marys	St. Marys R.	207.9	178.4	6,208	Secondary	6,300	560	None	
Indiana									
Ft. Wayne	Maumee R.	125.8	1,930	133,607	Secondary	130,000	19,300	None	Combined sewers.
Decatur	St. Marys R.	155.9	615	7,271	None	13,300	13,300	New Plant	Combined sewers. Final plans approved.
Auburn	Cedar Cr.	160.9	93.0	5,879	Secondary (See Remarks)	1,700	400 E	(See Remarks)	Small part of population tributary to S.T.P. Raw sewage to stream. Should collect and treat wastes. Combined sewers.

MAUMEE RIVER BASIN

TABLE 6. - DATA ON SOURCES OF POLLUTION
Municipalities with Populations Under 5,000

Municipality	Receiving Stream	Miles to Mouth of Maumee R.	Drainage Area, Sq. Mi.	1950 Census	Sewage Treatment	Population Equivalent Before Treatment	Population Equivalent Discharged to Rec'g Stream	Project Requirement	Remarks
Ohio									
Perrysburg	Grassy Cr. to Maumee R.	13.4	6,330	4,006	None	(3600) (1)	(3600) (1)	New Plant	Combined sewers. Detailed plans approved.
Waterville	Maumee R.	19.9	6,314	1,110	None	(1000) (1)	(1000) (1)	New Plant	Combin'd sewers.
Grand Rapids	Maumee R.	30.1	6,231	657	None	(590) (1)	(590) (1)	New Plant (2)	No comprehensive system of sewers.
Antwerp	Maumee R.	98.4	2,040	1,162	None	1,040 E	1,040 E	New Plant	Combined sewers.
Whitehouse	Swan Cr.	28.9	1.8	849	None	(760) (1)	(760) (1)	New Plant (2)	No comprehensive system of sewers. Final plans approved.
Swanton	Swan Cr.	39.0	24.7	1,740	None	(1560) (1)	(1560) (1)	New Plant	Combined sewers. Plans under preparation.
Haskins	Haskins Cr.	22.4	10	469	Primary	(420) (1)	See Remarks	Additions & Corrections	Do not use treatment plant. Combined sewers.
Weston	Tontogany Cr.	32.4	8.7	973	None	650 E	650 E	New Plant	Combined sewers. General plans approved. Plans under preparation.
Deshler	Beaver Cr.	47.8	30.0	1,629	None	1,170 E	1,170 E	New Plant	Combined sewers. Plans under preparation. Load includes 300 estimated pop. equiv. from Koppenhoefer Prod. & Creamery Co.
Leipsic	Beaver Cr.	56.7	4.0	1,706	None	(1540) (1)	(1540) (1)	New Plant	Combined sewers. Final plans approved.
Delta	Bad Cr.	45.1	50.0	2,120	None	1,900 E	1,900 E	New Plant	Combined sewers. Plans under preparation.
Liberty Center	Dry Cr.	39.5	24.0	816	None	(730) (1)	(730) (1)	New Plant (2) & System	No comprehensive system of sewers. General plans approved. Plans under preparation.
Wauseon	N. Turkeyfoot Cr.	54.0	6.1	3,494	Secondary	4,280 (Normal) 25,600 (Max.)	650	Additions	Canning Co. included.
Holgate	S. Turkeyfoot Cr.	52.0	14.0	1,092	None	980 E	980 E	New Plant	Combined sewers.
Hamler	Br. of S. Turkeyfoot Cr.	55	25.4	490	None	(440) (1)	(440) (1)	New Plant (2) & System	No comprehensive sewer system.
Continental	Powell Cr.	83.1	3.3	1,023	None	920 E	920 E	New Plant	Combined sewers.
Paulding	Flatrock Cr.	85.3	172	2,352	None	2,100 E	2,100 E	New Plant	Combined sewers.
Payne	Flatrock Cr.	97.3	112	1,062	None	960 E	960 E	New Plant	Combined sewers.
Convoy	Hagerman Cr.	109 3		910	Secondary	880	130 E	None	Separate sewer system.
Ohio City	Prairie Ditch	118.7	5 0	861	None	770 E	770 E	New Plant	Combined sewers.
Ottawa	Blanchard R.	108.9	632	2,962	None	3,000 E	3,000 E	New Plant	Combined sewers. Final plans approved.
Forest	Blanchard R.	170.4	2.9	1,114	None	(1000) (1)	(1000) (1)	New Plant	Combined sewers.
Dunkirk	Blanchard R.	185.0	3.0	972	None	(870) (1)	(870) (1)	New Plant	Combined sewers.
Pandora	Riley Cr.	119.8	80.9	717	None	640 E	640 E	New Plant	Combined sewers.
Bluffton	Riley Cr.	127.5	70.8	2,415	None	2,170	2,170	New Plant	Combined sewers. Under construction.
Rawson	Ottawa Cr.	135.5	2.3	407	None	370 E	370 E	New Plant	Combined sewers.
Arlington	Br. of Eagle Cr.	152.9	6.8	825	None	(740) (1)	(740) (1)	New Plant	Combined sewers.
Kalida	Ottawa R.	98.8	306	533	None	(480) (1)	(480) (1)	New Plant (2)	No comprehensive system of sewers.
Ada	Hog Cr.	150.8	12.5	3,640	None	3,000 E	3,000 E	New Plant	Combined sewers. Final plans approved.

MAUMEE RIVER BASIN

TABLE 6. - DATA ON SOURCES OF POLLUTION - Continued.
Municipalities with Populations Under 5,000

Municipality	Receiving Stream	Miles to Mouth of Maumee R.	Drainage Area, Sq. Mi.	1950 Census	Sewage Treatment	Population Equivalent Before Treatment	Population Equivalent Discharged to Rec'g Stream	Project Requirement	Remarks
Ohio									
Columbus Grove	Plum Cr.	108.6	24.2	1,936	Secondary		340	None	Putnam County Canning Co. & Milk Co. tributary.
Cridersville	Little Ottawa R.	132.5	Less than 1	684	None	620 E	620 E	New Plant	Combined sewers.
Spencerville	Six Mile Cr.	123.4	3.5	1,826	None	170 E	170 E	New Plant	Combined sewers.
Stryker	Tiffin R.	98.1	444	1,026	None	1,030	1,030	New Plant	Combined sewers.
Archbold	Flat Run	109.7	2.0	1,486	None	1,490	1,490	New Plant	Combined sewers.
Fayette	Deer Cr.	122.8	13.6	1,003	None	1,000	1,000 (See Remarks)	New Plant	Fayette Canning Co. & Beaverson slaughterhouse trib. to city sewers but not included in estimated load. Combined sewers. Plans under preparation.
Sherwood	Sulphur Cr.	76.1	12.5	570	None	510 E	510 E	New Plant	Combined sewers.
Hicksville	Br. of Gordon Cr.	90.5	5.1	2,629	Secondary	5,590	780	Enlargement	Harkey Canning Co. trib. to plant. Combined sewers. Plans under preparation.
Edgerton	St. Joseph R.	170.4	436.4	1,246	None	1,120 E	1,120 E	New Plant	Combined sewers.
Montpelier	St. Joseph R.	191.5	329.4	3,867	None	3,490 E	3,490 E	New Plant	Combined sewers.
Edon	Bear Cr.	185.0	2.0	645	None	(650) (1)	(650) (1)	New Plant (2)	No comprehensive sewer system.
Pioneer	Clear Fk.	202.0	28.5	696	None	630 E	630 E	New Plant	Combined sewers.
Rockford	St. Marys R.	171.7	314	1,112	None	720 E (1000) (1)	720 E (1000) (1)	New Plant	Combined sewers.
Mendon	St. Marys R.	183.4	259	632	None	320 E (570) (1)	320 E (570) (1)	New Plant	Combined sewers.
New Bremen	Wirth Ditch	219.0	3.9	1,546	Secondary	2,800	50	None	Combined sewers.
Indiana									
New Haven	Maumee	121	1,940	2,336	Secondary		500 E	None	Combined sewers.
Berne	Gates Ditch to Blue Cr.	179	Negligible	2,277	None	920 (2049) (1)	920 (2049) (1)	New Plant	Combined sewers.
Waynedale	Little St. Marys R.	135	16.9	2,500 E	None	70 (2250) (1)	70 (2250) (1)	New Plant (2)	Unincorporated. No comprehensive system of sewers.
Baer Field (Ft. Wayne)	Little St. Marys R.	137	15.3	300	Secondary		40 E	None	Separate sewer system. Only primary treatment used at this time.
St. Joe	Bear Cr.	154	690	479	None	50 E (430) (1)	50 E (430) (1)	New Plant (2)	No comprehensive sewer system.
Grabill	Grabill Ditch to St. Joseph R.	146	2.4	370	None	30 E (330) (1)	30 E (330) (1)	New Plant (2)	No comprehensive sewer system.
Waterloo	Cedar Cr.	167	52.5	1,414	See Remarks	180 (850) (1)	180 (850) (1)	Replacement with New Plant	Separate sewer system. Has some treatment by septic tank.
Garrett	Garrett Ditch	160	6.2	4,291	None	1,500 (3860) (1)	1,500 (3860) (1)	New Plant	Combined sewers. Order issued.
Avilla	Eley Ditch	161	4.0	669	None	100 E (600) (1)	100 E (600) (1)	New Plant	Separate sewer system.
Monroeville	Br. of Flatrock Cr.	112	43	1,150	None	600 E (1040) (1)	600 E (1040) (1)	New Plant	Combined sewers. Final plans approved.
Butler	Big Run Cr.	174	16.2	1,914	See Remarks	1,730 E	1,730 E	Replacement with New Plant	Combined sewers. Has some treatment in septic tank.

Notes: "E" indicates estimated values.

(1) Population centers with no comprehensive sewer system or with systems serving only a part of population. The population equivalent values listed are those expected to be tributary to a comprehensive sewer system when constructed.

(2) Population centers with no comprehensive sewer systems. Waste load needing treatment under present conditions is dependent on load contributed by private sewers. Installation of comprehensive sewer systems will require treatment in a central plant.

MAUMEE RIVER BASIN

TABLE 7. - DATA ON SOURCES OF POLLUTION - INDUSTRIES (1)

Industry	Receiving Stream	Miles to Mouth of Maumee R.	Drainage Area, Sq. Mi.	Waste Treatment	Population Equivalent Before Treatment	Population Equivalent Discharged to Rec'g Stream	Project Requirements	Remarks
Ohio								
Standard Oil Co., Toledo	Maumee R.	0.0	6,586	Oil-water separator		64,600	Additional corrective measures	55,000 Bbl. (total) crude per day. Includes Pure Oil Co. wastes.
Gulf Oil Co., Toledo	Maumee R.	1.5	6,586	Oil-water separator		21,200	Additional corrective measures	Refinery - 40,000 Bbl. per day.
Interlake Iron Co., Toledo	Maumee R.	1.6	6,585	None		83,700	Corrective measures	Blast furnace - 1,275 tons ore per day. Coke plant - 1,800 tons coal per day.
Glass Fibre, Waterville	Maumee R.	17.8	6,320	Sand filters for san. sewage only. No treatment for industrial wastes.		2,800	Corrective measures	Phenol wastes. Pop. equiv. figured on industrial waste.
Campbell Soup, Napoleon	Maumee R.	44.8	5,646	Screening		35,700	Additional corrective measures	Major industrial plant extension program undertaken. Industrial waste correction program underway.
Central Foundries Div., G.M.C., Defiance	Maumee R.	59.9	5,580	None		1,090	Corrective measures	
Christ Diehl Brewing Co., Defiance	Maumee R.	63.2	5,510	None		3,800 E	Corrective measures	Pop. equiv. based on water consumption and production.
Sun Oil Co., Toledo	Otter Creek	5.0	8.0	Oil-water separator		17,500	Additional corrective measures	60,000 Bbl. crude oil per day.
Page Dairy, Whitehouse	Swan Creek	28.9	1.8	None		1,030	Corrective measures	Cottage cheese mfg. cream pasteurization.
Buckeye Canning Co., Weston	Tontogany Cr.	32.4	8.7	Screening & lagooning	2,380	See Remarks	None (See Remarks)	Controlled discharge of lagooned wastes. $NaNO_3$ treatment.
Libby, McNeill & Libby, Leipsic	Beaver Cr.	56.7	4.0	Screening		25,300	Corrective measures	Cannery
Pet Milk Co., Delta	Bad Cr.	45.1	50	None		1,900	Corrective measures	Evaporated Milk - 250,000 to 500,000 lbs. per day.
Pet Milk Co., Holgate	S. Turkeyfoot Cr.	52.0	14	None		750	Corrective measures	
Bauer Canning Co., Hamler	S. Turkeyfoot Cr.	52.0	25	Lagoon	1,600 E	See Remarks	Improvements (See Remarks)	1,000 cases whole tomatoes in #2 cans packed per day. Controlled discharge from lagoons.
Foster Canning Co., Napoleon (Rural Rt.)	Vannyning Cr. to Maumee R.	46.4	5,642	Screening		650	Additional corrective measures	Tomato and tomato products. Plans approved for lagoons with controlled discharge. Negotiations with Napoleon for disposal of wastes to municipal system.
Koch Brewing Co., Wapakoneta	Auglaize R.	142.1	108	None		70	Corrective measures	Most of waste tributary to municipal sewers. Complete service by municipality indicated.
Walter & Son Packing Co., Wapakoneta	Auglaize R.	143.2	108	Settling		0	Corrective measures	Meat packing. Present facilities entirely inadequate.
Bohrer & Moore, Wapakoneta	Auglaize R.	143.2	108	Settling		440	Corrective measures	Meat packing. Present facilities entirely inadequate.
Stokely Packing Co., Paulding	Flatrock Cr.	85.3	172	Lagoon	5,600 E	See Remarks	Minor improvements. (See Remarks)	125,000 cases of whole tomatoes in #2 cans per year. Controlled discharge from lagoons.
Sharp Canning Co. Ohio City	Prairie Ditch	118.7	5.0	None		8,800	Corrective measures	Tomato processing

MAUMEE RIVER BASIN

TABLE 7. - DATA ON SOURCES OF POLLUTION - INDUSTRIES [1] - Continued.

Industry	Receiving Stream	Miles to Mouth of Maumee R.	Drainage Area, Sq. Mi.	Waste Treatment	Population Equivalent Before Treatment	Population Equivalent Discharged to Rec'g Stream	Project Requirements	Remarks
Ohio								
Buckeye Sugar Co., Ottawa	Blanchard R.	109.7	632	See Remarks		31,200 (At time of survey)	Additional corrective measures on basis of survey (See Remarks for corrective action taken since survey.)	Process and flume water treated or settled and reused. Condenser water cooled and discharged. Lime cake slurry lagooned. Overflow of excess flume water increased load to stream at time of survey. Steps have been taken to discharge excess flume water to lagoons with controlled release to stream. Since survey (in 1952) seasonal tomato processing added to beet sugar operation. Wastes are lagooned and discharge controlled.
Findlay Provision Co., Findlay	Blanchard R.	139.2	343	None		750	Corrective measures	Prepared meat products. Negotiations underway to discharge pretreated waste to Findlay municipal system.
Riverside Packing Co., Findlay	Blanchard R.	139.1	343	None		1,000	Corrective measures	Meat packing. Negotiations underway to discharge pretreated waste to Findlay municipal system.
Kirschner Packing Co., Findlay	Blanchard R.	140.9	343	Grease removal.		5,000	Corrective measures	Meat packing. Negotiations underway to discharge pretreated wastes to Findlay municipal system.
St. Marys Packing Co., Delphos	Jennings Cr.	111.1	74	Lagoon	4,500	See Remarks	Additional corrective measures	60,000 cases each peas, beans, beets. 120,000 cases tomatoes per season. Controlled discharge.
New Delphos Mfg. Co., Delphos	Jennings Cr.	111.1	74	Lagoon	--	--	None	12,000 g.p.d. pickling tank rinse water. Controlled discharge from lagoons.
St. Marys Woolen Mills, St. Marys	Miami-Erie Canal	139	--	None		8,910	Corrective measures	
Nameplate & Monogram Co., Spencerville	Six Mile Cr.	123.4	3.5	Improved waste elimination	--	--	Corrective measures	Plating wastes.
Wintzer & Son, Wapakoneta	Pusheta Cr.	197.1	20	Act. sludge	7,260	20	None	Rendering plant.
Eckert Packing Co., Defiance	Tiffin R.	64.6	804	None		2,200	Corrective measures	Meat packing.
Lugbill Packing Co., Archbold	Brush Cr.	96.1	39	Grease removal & screening		1,900	Corrective measures	Plans under preparation.
Peter Eicher & Son, Archbold	Flat Run	109.7	2.0	Screening & settling		720	Additional corrective measures	Poultry slaughter
La Choy Div., Beatrice Foods, Inc., Archbold	Flat Run	109.7	2.0	Screening, settling, & tr. filters.	25,000 E	3,500 E	Minor improvements	Cannery
Airline Packing Co., Edgerton	St. Joseph R.	158	436	See Remarks	16,500		Corrective measures	Leaching pit for heavy solids wastes. Process peas, beans, & tomatoes.
Wabuck Packing Co., Blakeslee	Bear Cr.	167	27	None		810	Corrective measures	Tomato processing
Edon Packing Co., Edon	Bear Cr.	171	12	None		1,500	Corrective measures	Tomato processing
Scheiber Canning Co., Edon	Bear Cr.	171	Negligible	None		1,200 E	Corrective measures	Tomato processing. Plans under preparation.
Sharp Canning Co. Rockford	St. Marys R.	171.7	314	None		14,600	Corrective measures	Tomato processing
Stokely Packing Co., Mendon	St. Marys R.	183.4	259	None		8,320	Corrective measures	Tomato processing

MAUMEE RIVER BASIN

TABLE 7. - DATA ON SOURCES OF POLLUTION - INDUSTRIES (1) - Continued.

Industry	Receiving Stream	Miles to Mouth of Maumee R.	Drainage Area, Sq. Mi.	Waste Treatment	Population Equivalent Before Treatment	Population Equivalent Discharged to Rec'g Stream	Project Requirements	Remarks
Ohio								
Vanderhorst Canning Co., St. Marys	St. Marys R.	207.9	178	None		1,000	Corrective measures	Tomato processing
Weston Paper Co., St. Marys	St. Marys R.	207.9	178	See Remarks		18,800	Corrective measures	Some reuse of process water.
St. Marys Packing Co., St Marys	St. Marys R.	207.9	178	Screening		10,070	Corrective measures	Tomato processing
Goodyear Rubber Co., St. Marys	St. Marys R.	207.9	178	None		320	Corrective measures	Rubber products, pliofilm, plastics, plating.
White Mountain Creamery, New Bremen	Wirth Ditch	219	3.9	Act. sludge	6,500	40	None	
Page Dairy Co., Bluffton	Riley Cr.	127.5	171	None		900	Corrective measures	Contract has been made with Bluffton for discharge of waste to municipal system
Triplett Electric Co., Bluffton	Riley Cr.	127.5	171	None	--	--	Corrective measures	Electroplating. Contract has been made with Bluffton for discharge of waste to municipal system.
National Refining Co., Findlay	Oil Ditch to Blanchard R.	139.5	343	Oil separator		2,800	Additional corrective measures	Oil separator constructed 1952.
Great Lakes Sugar Co., Findlay	Oil Ditch to Blanchard R.	139.5	343	See Remarks		34,600	Corrective measures	Some process water reused. Plant has not operated during 1951 and 1952.
Central Steel & Rubber Co., Findlay	Oil Ditch to Blanchard R.	139.5	343	Settling lagoon		6,000	Corrective measures	Reclaim rubber
Ohio Oil Co., Findlay	Oil Ditch to Blanchard R.	139.5	343	Lagoon	250		None	Lagoon placed in operation 1952.
Standard Oil Co. Lima	Ottawa R.	130.3	133	Oil-water separator		18,300	Additional corrective measures	New oil separator installed in 1951.
Republic Creosoting Co., Lima	County Ditch to Ottawa R.	131.0	133	None		1,200	Corrective measures	Phenol wastes.
Cantieny-Strawn Co., Lima	County Ditch to Ottawa R.	131.0	133	Settling		120	Additional corrective measures	Meat packing
Shafer Slaughterhouse, Lima	Lost Cr. to Ottawa R.	131.0	133	Sand filters	600 E	30 E	Minor improvements	
Indiana								
Goeglein Slaughterhouse, Fort Wayne	Bullerman Ditch to Maumee R.	124	5.0	Screening & lagoon		400 E	Additional corrective measures	Custom slaughtering
Parrott Packing Co., Ft. Wayne	Maumee R.	122	1,939	None		6,080	Corrective measures	Meat packing
International Harvester, Ft. Wayne	Harvester Ditch	124	Negligible	None		9,500	Corrective measures	Soluble oil wastes. Final plans approved.
Gladieux Oil Sales, Ft. Wayne	Harvester Ditch	126	2.0	Lagoon	--	--	Additional corrective measures	Oil and brine wastes
Magnavox Co., Ft. Wayne	Harvester Ditch	126	2.0	None	--	--	Corrective measures	Plating rinse waters.
Wayne Coop. Milk Producers, Inc., Ft. Wayne	Highland Pk. Drain to St. Jos. R.	131	Negligible	2 stage trickling filter plant with recirculation	3,900	600	Additional corrective measures	
Salisbury Axle Div., Dana Corp., Ft. Wayne	Local Ditch to Spy Run Cr.	133	Negligible	Lagoon	--	--	None	Soluble oils and plating wastes.
United Milk Products Co., Berne	Blue Cr.	179	Negligible	High rate trickling filter plant with recirculation	1,550	180	None (See Remarks)	Effluent to city sewer to Blue Cr.

MAUMEE RIVER BASIN

TABLE 7. - DATA ON SOURCES OF POLLUTION - INDUSTRIES [1] - Continued.

Industry	Receiving Stream	Miles to Mouth of Maumee R.	Drainage Area, Sq. Mi.	Waste Treatment	Population Equivalent Before Treatment	Population Equivalent Discharged to Rec'g Stream	Project Requirements	Remarks
Indiana								
Central Soya Co., Decatur	St. Marys R.	156	615	None		6,040	Corrective measures (See Remarks)	Plan connection to city sewer. Soy bean processing for animal feeds mainly.
Grabill Canning Co., Grabill	Grabill Ditch to St. Jos. R.	146	2.4	None		300 E	Corrective measures	
Hall Stingle Canning Co., Waterloo	Cedar Cr.	167	52	Lagoon	390 E	See Remarks	None (See Remarks)	5000 cases of Puree in No. 10 cans per year. Controlled discharge
DeKalb Canning Co., Auburn	Cedar Cr.	161	93	Lagoon	1,450 E	See Remarks	None (See Remarks)	20,000 cases No. 2 cans whole tomatoes per year. 10,000 cases 46 oz. cans juice per year. Controlled discharge.
No. Ind. Fuel & Light Co., Auburn	Local Ditch to Harter Ditch	161	Negligible	None	--	--	Additional corrective measures	Abatement ordered. Process changes have been made to reduce phenol wastes.

(1) Includes only those industries not connected to municipal sewerage systems.

E - Estimated Computations based on production values furnished by the industrial establishment.

MAUMEE RIVER BASIN

TABLE 8. - SUMMARY OF BACTERIOLOGICAL RESULTS (1) (2)

Sampling Point	Period of Record (Dates are Inclusive)	Coliform Index Indicated Number Per 100 Milliliters			% Samples with Index Equal to or Greater than 10,000 per 100 ml	
		Period Ave.	Max. Month	Min. Month	Period of Record	Max. Month
Defiance Waterworks Intake (3)	1950 - 52	Greater than 6900	Greater than 10,000	1,000	65	100
Napoleon Waterworks Intake (3)	1951 - 52	Greater than 3600	Greater than 8,500	600	30	83
Bowling Green Waterworks Intake	Insufficient Results					
Waterville Waterworks Intake	Insufficient Results					
Maumee-Perrysburg Bridge	June - Sept. 1950 March - Sept. 1951	22,000	153,000	800	27	80
Maumee River near Mouth (4)	June - Sept. 1950 March - Sept. 1951	340,000	2,000,000	16,000	74	100

FOOTNOTES

(1) Samples collected five days per week during period of record except at Maumee-Perrysburg Bridge and Maumee River near mouth during March, April and May, 1951, when only two samples per week were collected. Results based on 48-hour readings of presumptive tests in lactose broth.

(2) Results at waterworks intakes for Lima, Findlay, Van Wert, Wauseon, Swanton, Delta, Archbold and Weston fall within limits of bacterial quality objective and are not summarized.

(3) Dilutions tested were such that the maximum determinable index was 10,000 per 100 milliliters. Period average and maximum month average might have been much greater if additional dilutions had been tested.

(4) Effluent from Toledo Sewage Treatment Works (primary treatment) is discharged above this point. Effluent is chlorinated during July, August and portions of June and September. Chlorination reduces index about 90%.

MAUMEE RIVER BASIN

TABLE 9. - SUMMARY OF INDUSTRIES HAVING DEOXYGENATING WASTES (1)

Type of Industry	Plants Investigated	Population Equivalents of Wastes as Discharged
Ohio		
Paper	1	18,800
Meat	10	12,310
Milk	5	4,620
Canning	17 (2)	127,950
Oil Refining	6	124,400
Sugar Beet	2	65,800
Coke by-product	1	83,700
Miscellaneous	9	24,210
Total Ohio	51	461,790
Indiana		
Meat	2	6,480
Milk	2	780
Canning	3 (2)	300
Soya Processing	1	6,040
Miscellaneous	1	9,500
Total Indiana	9	23,100
Grand Total	60	484,890

(1) Includes only those industries not connected to municipal sewerage systems.

(2) Includes four canneries in Ohio and two in Indiana which have lagoons with controlled discharge. No population equivalent is included for these canneries on the assumption that no waste load is discharged to streams during critical low flow periods.

MAUMEE RIVER BASIN

TABLE 10. - SUMMARY OF INDUSTRIES HAVING SIGNIFICANT WASTES OTHER THAN DEOXYGENATING MATERIALS (1)

Name of Industry	Location
Oil Wastes	
Standard Oil Co. (2)	Lima
Standard Oil Co. (2) (Includes Pure Oil Co. wastes)	Toledo
Gulf Oil Co. (2)	Toledo
Sun Oil Co. (2)	Toledo
National Refining Co. (2)	Findlay
Ohio Oil Co. (2)	Findlay
Gladieux Oil Sales (3)	Ft. Wayne
Salisbury Axle Division, Dana Corp. (3)	Ft. Wayne
International Harvester Co. (2)	Ft. Wayne
Acid and Metal Wastes	
New Delphos Mfg. Co.	Delphos
Nameplate & Monogram Co.	Spencerville
Triplett Electric Co.	Bluffton
Magnavox Co.	Ft. Wayne
Salisbury Axle Division, Dana Corp. (3)	Ft. Wayne
Goodyear Rubber Co. (2)	St. Marys
Phenolic Wastes (4)	
Interlake Iron Co., (By-product coke plant) (2)(3)	Toledo
No. Indiana Fuel & Light Co.	Auburn

MAUMEE RIVER BASIN

TABLE 10. - SUMMARY OF INDUSTRIES HAVING SIGNIFICANT WASTES OTHER THAN DEOXYGENATING MATERIALS (1) (Cont'd)

Name of Industry	Location
Phenolic Wastes (Cont'd)	
Glass Fibre (2)	Waterville
Republic Creosoting Co. (2)	Lima
Brine Wastes	
Gladieux Oil Sales (3)	Ft. Wayne
Miscellaneous Wastes (5)	
Central Foundries Division, G.M.C. (2)	Defiance
Interlake Iron Co., (Blast furnaces) (2)(3)	Toledo
St. Marys Woolen Mills - Dyes and strong acid wastes (2)	St. Marys
Central Steel and Rubber Co.	Findlay

(1) Includes only those industries not connected to municipal sewerage systems.

(2) Also included in table 9 as discharging deoxygenating wastes.

(3) Listed elsewhere in this table as having significant wastes of another type.

(4) In addition to the industries listed significant quantities of phenols were measured in the wastes from the oil refineries at Lima and Toledo.

(5) Does not include industries having predominantly significant wastes classified elsewhere, even though many of them would have wastes causing miscellaneous effects not specifically classified.

MAUMEE RIVER DRAINAGE BASIN

SOURCES OF SIGNIFICANT POLLUTION

1950-51 SURVEY

OHIO DEPARTMENT OF HEALTH

AND

INDIANA STREAM POLLUTION CONTROL BOARD

FIGURE 6